

Rm 251

THE UNIVERSITY
OF ILLINOIS

LIBRARY

540.5

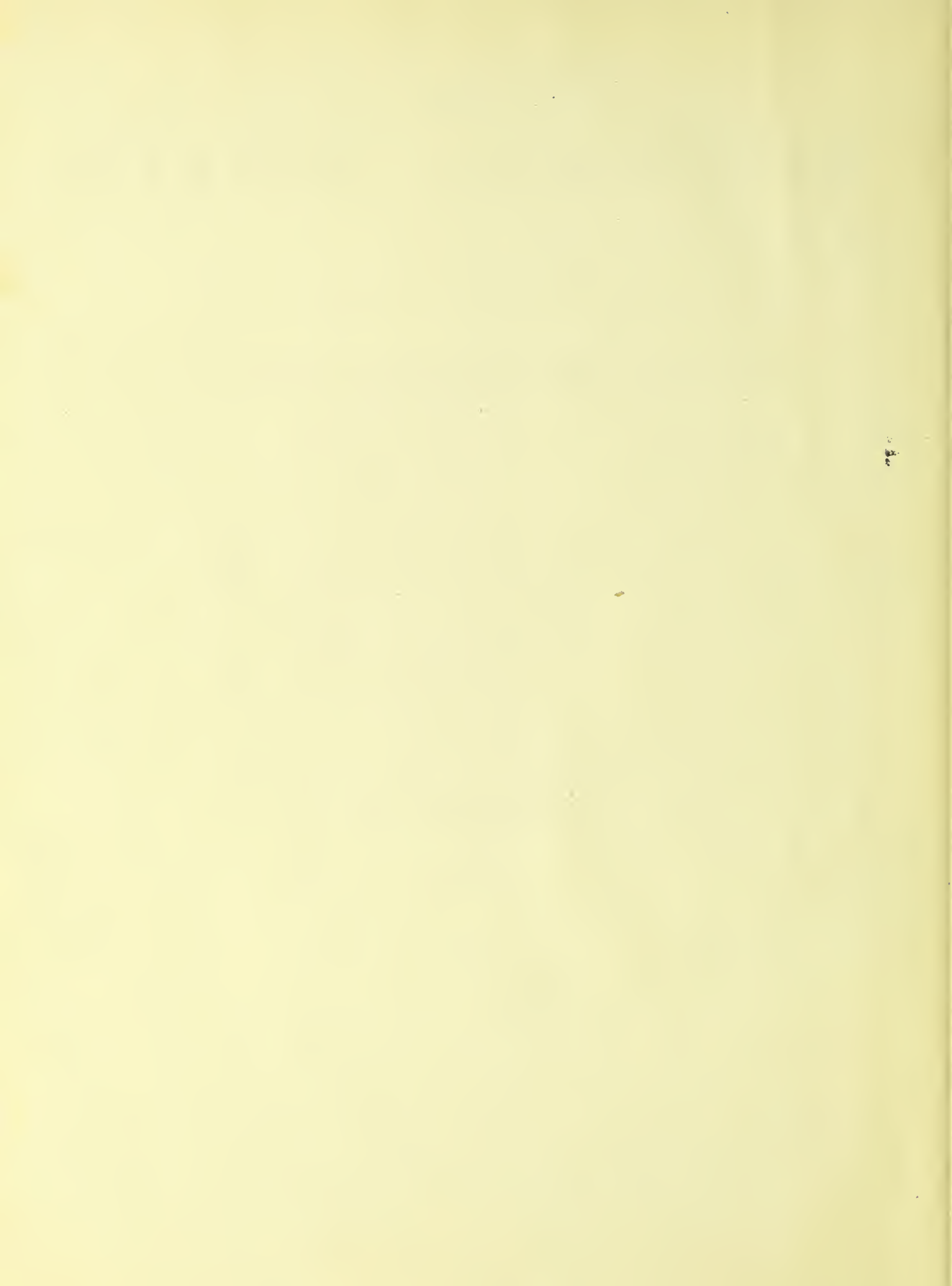
CHE

v.3

REPRODUCTION

~~REPRODUCTION~~

~~REPRODUCTION~~



THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY
W. P. DREAPER, F.I.C.

VOLUME III.
1914

LONDON
J. & A. CHURCHILL
7 GREAT MARLBOROUGH STREET



Digitized by the Internet Archive
in 2014

<https://archive.org/details/chemicalworldoff3191sout>

THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY W. P. DREAPER, F.I.C.

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

Vol. III. No. I.

JANUARY, 1914.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.

The Public Analyst.

Modern conditions of working have so influenced the work of this official, by increasing its cost and responsibility, that a joint committee of the Institute of Chemistry and the Society of Public Analysts has recently reviewed the position in detail.

As a result, the Council of the Institute of Chemistry and the Council of the Society of Public Analysts have expressed the opinion that, under the conditions attaching to these appointments, professional chemists of the proper type will no longer be attracted by this work; and that it is desirable that this circumstance should be considered whenever a vacancy occurs in the office of public analyst.

It has been found possible to formulate a scale of remuneration to apply under county and municipal appointments, and this must be considered a distinct step in the right direction. It is now laid down that, under the Sale of Food and Drugs Act, the total remuneration should be equivalent to a minimum fee of £1 1s. per sample dealt with for the first 100 examined; and that for a moderate number of samples (per annum) of from 200 to 500 the fee should not be less than 15s. per sample. Also that the fee for the examination of any sample under the Fertilisers and Feeding Stuffs Act should not be less than £1 1s.

This decision cannot fail to have an important bearing on this question and act in the direction of an increasingly efficient service and the upholding of this branch of chemical investigation in the eyes of the public. Adulteration as practised to-day is, in many cases, of a highly scientific order, and may give the analyst great trouble in proving its presence. Such service must be correspondingly remunerated by those who ultimately secure the benefit for the same in the supply of an ever-increasing purity in food supply. The articles which are appearing in this journal on the food and drug conditions which exist in the leading countries indicate the need for ever-increasing vigilance in this direction.

It will never do for the analyst to receive the impression that he is not being treated by the public authorities with that respect which is meted out to other officials of a similar standing. Any attempt to actually reduce the scale of remuneration must be

fought tooth and nail; the tenure of office should be made more certain, also provision for the inclusion of public analysts in any superannuation scheme which may exist for the time being.

INTERNATIONAL ASSOCIATION OF CHEMICAL SOCIETIES.

The following particulars have been published.

All members of Council, excepting the delegates from the "Verein Oesterreichischer Chemiker," the "American Chemical Society," the "Tokyo Chemical Society," and the "Polyteknisk Forenings Kemikergruppe, Kristiania," were present at the meetings of the third session of the Council on September 19th to 23rd last in Brussels. There were also present, in an advisory capacity only, C. Marie (Société de Chimie-Physique), F. Auerbach (Deutsche Bunsen Gesellschaft), T. M. Lowry (Faraday Society).

The officers were: Sir William Ramsay, *President*; Percy Faraday Frankland, *Vice-President*; Arthur William Crossley, *General Secretary*.

Since the last meetings of the Council held in Berlin, in April, 1912, the Société Chimique de Belgique has joined the Association, the total membership of which may now be represented as 19,582.

Deutsche Chemische Gesellschaft ..	3,356
The Chemical Society (London) ..	3,202
Verein Oesterreichischer Chemiker ..	1,050
Société Chimique de Belgique ..	510
Kemisk Forening, Kjöbenhavn ..	155
Sociedad Española de Física y Química ..	353
American Chemical Society ..	6,091
Société Chimique de France ..	1,023
Nederlandsche Chemische Vereeniging ..	515
Società Chimica Italiana ..	654
Tokyo Chemical Society ..	567
Polyteknisk Forenings Kemikergruppe, Kristiania ..	125
Russian Chemical Society ..	410
Schweizerische Chemische Gesellschaft ..	367

The following Societies each sent one delegate in an advisory capacity:—

Deutsche Bunsen Gesellschaft für Angewandte Physikalische Chemie ..	777
The Faraday Society (London) ..	202
Société de Chimie Physique ..	225

19,582

* *

Professor Haller gave an account of the negotiations which had taken place between Ernest Solvay and representatives of the International Association and which resulted in Monsieur Solvay making an unconditional gift of 250,000 francs to the Association. Further, Monsieur Solvay proposed to found an "International Institute of Chemistry," which shall have for its object the facilitation of the study and progress of chemistry, without, however, excluding problems belonging to other branches of the natural sciences, provided these have some bearing on the science of chemistry.

The Institute will have an annual income of 55,000 to 56,000 francs, the interest on 1,000,000 francs, which is to be distributed in such a manner that, for the next twenty-eight years, two-thirds of this sum (37,500 francs) will be placed at the disposal of the International Association of Chemical Societies, whilst the remaining third will be employed in establishing scholarships for Belgian students.

The Council gratefully accepted Monsieur Solvay's offers and proceeded to consider the Statutes of the "Institut International de Chimie Solvay," which with some slight alterations were adopted.

M. Solvay has also provided the International Association with offices in Brussels, where the archives will be kept and a permanent secretary is to be appointed to take charge of them, and to conduct the general business of the Association.

The Council considered the Statutes of the International Association, in which some alterations were necessitated; for as the Association has become possessed of funds, certain provisions of Belgian law must be complied with, and the Statutes have therefore been referred for revision and will be finally considered at the next meeting of the Council.

The members of the delegation of the Council of the Association on the governing body of the "Institut International de Chimie Solvay" (Messrs. Haller, Ostwald and Ramsay) together with Messrs. Guye, Paterno, Van Laer and Walden were appointed a commission to report at the next session of the Council on the employment of the financial resources of the Association; and further to advise the Bureau (a) on the investment of the funds belonging to the Association; (b) on the use of the interest arising therefrom, (c) on the use of the income of the "Institut International de Chimie Solvay."

Professor Haller was elected President of the Association for the ensuing year, the next meetings to be held in Paris, during the first fifteen days of September, 1914. The officers of the Association are:—*President*: Albin Haller, 10, rue Vauquelin, Paris; *Vice-President*: M. Hanriot, 11, Quai Conti, Paris; *General Secretary*: A. Béhal, 4, Avenue de l'Observatoire, Paris.

Statutes for the affiliation of the "International Committee on Atomic Weights" were discussed and with certain alterations they were accepted by the Council, provided the International Committee on Atomic Weights is willing to adopt the suggested alterations.

Professor Guye presented a report on the "Unification of Abbreviations of Titles for Scientific Journals used in Chemical Memoirs," and gave an explanation of its aims and objects. As a result of the discussion which followed, the Council decided to communicate with the editors of all periodicals publishing chemical memoirs.

Professor Werner explained the report of the commission appointed to consider the question of "the mitigation of the difficulties arising from the existing multiplicity

of languages employed in scientific literature," and pointed to the possibility of the formation of an International Journal of Abstracts in three languages, in which all publications of a chemical nature would be dealt with.

After prolonged discussion the commission was re-appointed to report to the next meeting of the Council, more particularly on three points:—(a) the publication of an International Journal of Abstracts in three languages; (b) the publication of three editions of an International Journal of Abstracts, namely, in English, French and German; (c) the publication of an International Journal, containing translations into either English, French or German of original papers appearing in the lesser known languages.

In drawing up the list of symbols, the commission decided to adopt *as far as possible*, as a basis of notation, the following two principles, namely:—

1. Each symbol shall have only one definite signification.
2. Where it appears impossible to avoid using the same letter for different quantities, the symbols shall be distinguished by a letter, added as subscript.

This second principle was also adopted in the case of individual members of a group, *e.g.*, volume, specific volume, molecular volume, critical volume, etc. The commission, however, recognised that there are practical difficulties in the way of a strict adherence to these principles.

"After consideration of the reports of the National Committees, this Council is unanimously in favour of adopting the symbols: I for Iodine, Xe for Xenon, W for Wolfram, Nb for Niobium, but is of opinion that the question of adopting the symbol Be for Beryllium, in place of Gl, should be referred to the prospective International Commission on Inorganic Nomenclature, with a strong recommendation in favour of the symbol Be. The committee recommends that in indexing inorganic compounds the constituent atoms, including carbon, should be arranged in alphabetical order.

In order to facilitate reference to compounds containing water of crystallisation, it is suggested that it would be desirable to insert, after the formula of the anhydrous compound, the formulae of the hydrated varieties, both in the form $F + xH_2O$, and in the empirical form with the hydrogen and oxygen embodied therein. Binary compounds are to be regarded as additive and not as substitution compounds, the negative component forming the termination, and indicating the class of compound, and the positive component providing the name of the individual.

THE INSTITUTE OF METALS.

THE annual general meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers, S.W., on Tuesday and Wednesday, March 17th and 18th, 1914. The fourth May lecture is to be delivered by Professor E. Heyn, of Berlin, early in the month of May. Professor Heyn, who is one of the best known Continental metallurgists, will deal with the subject of "Internal Strains in Cold-wrought Metals and Some Troubles Caused Thereby." The Institute of Metals has just published a volume entitled "The Second Report to the Corrosion Committee," which contains, in addition to the important report presented at the recent Ghent Meeting of the Institute of Metals, a verbatim account of the discussion that took place at that meeting.

THE SIGNIFICANCE OF OPTICAL PROPERTIES.

By PROFESSOR HENRY E. ARMSTRONG.

THE tendency is growing to acknowledge more and more clearly the significance of optical as distinct from other physical properties as criteria of structure—but we must recognise in this as in other connexions that man lives not by bread alone: modern inquiry has proved to demonstration that a mixed diet is indispensable to growth and physical well being—and so it is in chemistry. Of late years, a certain school has shown no undue modesty in proclaiming its own merits and the supreme value of so-called physical chemistry and has even claimed not vaguely that it is the more virtuous branch; the time must soon come, however, when it will be again recognised that it is the office of the chemist to be primarily a chemist rather than a pseudo-physicist or pseudo-mathematician, when it will be admitted that chemistry is in large measure an art, not to be appreciated to the full by those whose soul hankers most after figures and who are hampered by the narrowness of outlook and love of precedent which seems to be in some measure engendered by physico-mathematical study.

I would range myself with my old and revered master Kolbe, whose full worthiness as a chemist and *Gediegenheit*—the English word fails me—has yet to be recognised by his countrymen; I would range myself with him in decrying the ever recurring tendency to introduce the metaphysical spirit into our science; it was this he had in view in criticising van't Hoff. Taking into account the state of knowledge, rather let it be said, of ignorance of structure at that time, his scepticism was not unjustifiable.

In days gone by chemists were content to regard weighing and measuring as necessary offices and did not pretend that these occupations were superior to preparative and constitutional studies; there is no obvious reason why a distinction should now be made, which was not necessary formerly, simply because the field of study is widened and it is found desirable to institute measurements in a greater variety of directions. It cannot be denied that at the present day many are passing as chemists who know no chemistry: indeed it is clear that we cannot afford much longer to neglect the development of practical aptitude in the way that we have done of late years; the voices of the physiologists have too long been those of men crying in the wilderness—of men crying in vain for help from those who should long since have given them methods of analysis and the means of characterising the various units into which the complex materials which are the outcome of vital processes are resolvable. This was the plaint of the President of Section I. (Physiology) at the recent meeting of the British Association for the Advancement of Science.

Optical peculiarities cannot be considered alone but must be discussed in connexion with chemical

properties, if valid conclusions are to be drawn. No better proof could be asked for than is afforded by the interminable discussion that has taken place over the connexion of optical properties with structure in the case of benzene—the net result being to leave the problem where it naturally belongs, in the hands of the chemist. This is the first and most important consideration I desire to urge with regard to the significance of optical properties—*they must in all cases be judged in relation to chemical behaviour, not independently.*

But looming in the distance there is a new criterion to be reckoned with—that of crystalline form. We have been too much in the habit, perhaps, of late years, of regarding what we are pleased to call structural formulæ as actually representative of structure: in reality they are neither more nor less than condensed symbolic expressions indicative of chemical behaviour, though they are expressions in which certain canons of our belief as to the manner in which combination is effected are embodied.

The centric formula of benzene—of which I may claim to be the true and first inventor—is an expression representative of all that is known of the chemical behaviour of the hydrocarbon; the Kekulé formula is not, as it misrepresents benzene as a triethenoid compound. In my opinion, it is useless to bring forward arguments based on optical or other physical properties in favour of this or that formula other than the centric: in this case the chemical arguments must be given first consideration—no formula which is not in entire accordance with the chemical behaviour of benzene can be accepted, the object with which the symbol is devised being to express this behaviour.

A true structural symbol is one in which the manner in which the atoms are to be regarded as packed and in which their arrangement in space is taken into account. In the case of benzene, this is done in the now well-known model proposed by Barlow and Pope. In this, the six atoms of carbon are arranged not in the single plane of a ring but in two superposed, parallel planes. Contiguity, in the case of this model, is not necessarily synonymous with combination; thus each hydrogen atom appears to be in contact with three carbon atoms, though it is in combination only with one; moreover, the carbon atoms are packed in groups of three in two planes. But the structure is none the less that indicated by the hexagon symbol and the symbol is to be regarded as the chemical key to the internal structure of the model of the molecule.

The most remarkable result of modern inquiry—the discovery that affinity is a directed force—is the immediate outcome of the recognition of the significance of optical properties: of the interpretation given by Biot and Herschel in the early years of

last century of the phenomena of optical rotatory power. Biot's great discovery of the power possessed by various liquids of deflecting plane polarised rays was attributed by him to molecular asymmetry; this doctrine was gradually developed by the labours of Pasteur and not a few others until in our time, it was finally fashioned into a consistent scheme by van't Hoff and Le Bel, Wislicenus and von Baeyer. It is customary to attribute chief credit to van't Hoff; his great merit lay, however, primarily in the fact that, being possessed of a geometrical habit of mind, he had the good sense to set out in logical form the consequences of the adoption of space formulæ and of the tetrahedral symbol in particular. It is a striking fact that he made no use of the hypothesis in the laboratory; it is clear that his instincts were not those of a working chemist and this we must not forget in appraising the ambit of his alluring speculations.

A vast amount of labour has been expended in the attempt to evaluate optical activity in terms of structure but with little success. Perhaps this is in no small degree because the chemical aspects of the problem have received a disproportionate share of attention; moreover, the need of taking dispersive power into consideration has been recognised only recently. It is to be expected that when the possible presence, in not a few cases, of isodynamic compounds is taken into account, a very different interpretation may be given of the phenomena of optical activity. The significance of optical properties in connexion with the occurrence of isomeric change in solutions has been abundantly demonstrated, notably by Lowry.

One other case may be referred to in which changes in optical properties may easily be misinterpreted unless due weight be given to chemical considerations—that afforded by the behaviour of optically active substances such as cane sugar when hydrolysed by acids, for example. It is certain that such changes are but the algebraic outcome, as it were, of a whole series of changes, so that they cannot be taken at their face value. To give an example. Wilhelmy's observations on the effect of acids on cane sugar are frequently quoted as proof of the validity of the law of mass action. As a matter of fact, the supposed proof holds only within certain degrees of concentration; but apart from this, there can be little doubt that a variety of changes take place in solutions, some in one, others in opposite directions, which balance. No simple interpretation of these can be given which justifies the application of the results as proof of a law, except of the well-known one to which the Duchess drew the attention of Alice in Wonderland, when she remarked: "The more there is of mine the less there is of yours."

The law of mass action is an axiomatic generalisation applicable strictly only to the ideal state of a perfect gas and one which must be used as a touchstone in interpreting the phenomena of change; it cannot be proved by any experiments made with solutions.

I call attention to this case, not merely on

account of its bearing on the significance of special properties but as an illustration of the ever-present need of taking chemical consideration fully into account.

Frankland, in his recent Presidential Address to the Chemical Society, in the course of his most valuable summary of the cases in which the Walden change takes place, refers to the difficulty of interpreting cases of inversion of optical activity, as these cannot always be ascribed to an inversion of the configuration but may arise either from a partial alteration in structure—such as attends the passage from the levorotatory into the dextrorotatory form of fructose or *vice versa*—or from the introduction of a radicle which changes the sign of the rotation. The optical behaviour of the compound is obviously of limited significance in such a case.

The significance of colour is well known. It is perhaps desirable to emphasise the fact that, so far as I have taken part in it, the inquiry into the origin of "colour" has always been a limited inquiry into the origin of *visible colour* and, in my opinion, is one which ultimately must be referred to certain properties of the human eye: it is not an inquiry into the power of the spectroscope to reveal the absorptive powers of substances generally. We shall do well to remember that *colour* is one of the most definite words in our language, rarely used in any metaphorical sense except in the case of the adjectival form, *colourable*, the dictionary definition being: "That in respect of which bodies have a different appearance to the eye independently of their form." It is remarkable how little additional information is afforded as to the origin of colour by the use of the spectroscope; the eye is competent to decide in most cases but it will be desirable in future to pay more attention to the dispersive power of coloured substances, in view of the possibility that in not a few cases the peculiarities that are noticeable are due to the presence of isodynamic chromophoric compounds. The anomalous dispersive power of some of the rosanilines, for example, is probably to be explained in this way.

Finally, whilst the exhibition of either dextrorotatory or levorotatory power is not in itself sufficient to characterise a substance except as one of asymmetric structure, the fact that a very large proportion of the constructive materials utilised in vital processes are optically active is one of the deepest significance, especially as there is reason to suppose that the great majority belong to one structural type—we may call it the right hand series, as they are mostly dextrorotatory. This circumstance is proof positive that the vital mechanism is endowed with marvellous selective power and that the chemical changes which constitute life are both strictly determined and according to pattern.

ROYAL INSTITUTION.—Discourses will probably be given by Prof. J. Norman Collie, Prof. W. A. Bone, Lord Rayleigh, Prof. Sir J. J. Thomson, Dr. A. Keith and others. Dr. J. A. Harker will give two lectures on "The Electric Emissivity of Matter," and Professor Sir J. J. Thomson, six lectures on "Recent Discoveries in Physical Science."

VOLATILE PAINT THINNERS.

By C. A. KLEIN.

DURING recent years numerous investigations have been made into the occupational sickness of the painter, and in consequence of the results obtained, a much broader view of the problem is asserting itself. Until quite recently it was considered that the use of lead compounds—particularly white lead—was the sole factor in determining the occupational sickness rate amongst painters, but in the light of later information this view has been considerably modified. Paint, as applied by the painter, is usually a mixture of a solid pigment suspended in a vehicle consisting of a drying oil with a volatile thinner. The object of the volatile thinner is in the main to dilute the paint so that a thin film can be obtained when the paint is applied. The proportion of thinner used is varied in order to produce different degrees of surface gloss. The present taste for flat surfaces necessitates the use of more volatile thinners, and as will be seen later, has increased the risk of the painter's work. Another class of paint, known as "quick drying paints or compositions," is used in enormous quantity. Such paints generally consist of a solution of a tarry or bituminous material in a volatile solvent, with or without a pigment, and are used for the protection of metal work, not only when exposed to atmospheric action, but also for the preservation of metal chemical plant, and in this connection it is important that users should be fully cognisant of the toxic properties of these products, so that efficient precautions may be taken. For many years turpentine was the only volatile thinner used in ordinary paints, and it is surprising that the toxic properties of this material were not appreciated until a comparatively short time ago. The investigations of Reinhard,¹ Lehmann,² Drescher,³ Schaefer,⁴ Goadby,⁵ Armstrong and Klein,⁶ have shown that very definite toxic properties must be ascribed to turpentine, and that due allowance is to be made for these when considering not only sickness amongst painters, but also the sickness sometimes observed in persons inhabiting freshly painted rooms.

Air charged with turpentine vapour to the extent of 0.003 to 0.004 granule per 1,000 c.c. produces severe symptoms of poisoning, and animals subjected to this concentration have in certain cases died after less than 3 hours' exposure. Rambousek⁷ states that turpentine acts as a local irritant, and when absorbed into the system has an exciting effect on the central nervous system. Inhalation of large quantities of

turpentine vapour causes giddiness, stupor, convulsions and other nervous disturbances, rapid breathing, palpitation, pains in the chest, bronchitis, and inflammation of the kidneys. Kidney affection is produced by the chronic action of turpentine vapours. Goadby (*loc. cit.*) is of the opinion that the observation of Garrod⁸ as to the prevalence of gout amongst painters and its absence amongst workers engaged in white-lead works is to be ascribed to the very definite action of turpentine on the kidney, and it is probable that the same cause is responsible for the frequent headaches of painters, an uncommon symptom amongst white-lead workers.

There is now no doubt as to the disturbing influence of turpentine vapours in man, and it is probable that the effects produced are such as to predispose the subject to the poisonous effects of compounds of lead and similar substances. This is largely in consequence of the disturbing influence exerted on the organs of elimination.

The enormous use of other readily volatile liquids as paint thinners has by no means improved the position, and it becomes necessary to give some consideration to this aspect of the problem. For some years past, thinners other than turpentine have been used, and the toxic properties of the vapours of such products have been recognised in their processes of manufacture.⁹ As yet, however, but little attention appears to have been given to their subsequent use.

The following solvents are used in large quantities, viz.: mineral oil products, benzene and some of its homologues, carbon di-sulphide, carbon tetrachloride, the chlorine derivatives of ethane and ethylene.

The mineral oil products have certain general effects common to nearly all such volatile products, viz., an injurious action on the central nervous system.¹⁰ This effect is more marked in the case of the low-boiling hydrocarbons. The high-boiling-point members of the group cause serious injury to the skin by contact, and a definite eczema is associated with their use,¹¹ but the effect is not peculiar to this class. Many of the lower boiling-point solvents are well-known skin irritants¹² probably by reason of their solvent action on the fat of the skin. Benzene and other low-boiling fractions find extensive application in certain varieties of paint, and definite symptoms are produced by the inhalation of their vapours.

Poisoning is characterised by headache, sickness, and giddiness, the latter resembling alcoholic intoxication, whilst, if much has been inhaled, unconsciousness, tremors, convulsions, difficulty in breathing,

¹ Reinhard. *D. Med. Wochenschr.*, 1887, S., 256.

² Lehmann. *Arch. f. Hyg.*, 1899, S., 321.

³ Drescher. *Zeits. f. med. Beamte*, 1906, S., 131.

⁴ Schaefer. *Hamburger Gew. Inspect. Arbeiten und Sonderabdrücke*, 1909, 5, 9.

⁵ Goadby. "Lead Poisoning and Lead Absorption," Arnold, London, 1912 (Legge and Goadby).

⁶ Armstrong and Klein. *Journ. Soc. Chem. Ind.*, 1913, 32, 320, 331; *Ghemische Industrie*, 1913, 17, 738.

⁷ Rambousek. "Industrial Poisoning," Arnold, 1913, 215.

⁸ Garrod. *Lancet*, 1870.

⁹ Rambousek. (*Loc. cit.*), 68.

¹⁰ Wood. *Trans. Amer. Soc. Mech. Engineers*, 1895, 16, 637.

¹¹ Koller. 7th Int. Congress App. Chem., London, 1909.

¹² Reports of Chief Inspector of Factories, 1910—1912.

and cyanosis follow. Chronic benzene poisoning is characterised by mental dulness, pains in limbs, tremor, muscular weakness—a train of symptoms formerly considered indicative of lead poisoning when the patient was a painter.

Benzene and its homologues have received attention at the hands of many workers in toxicology, and it is sufficient to record that Rambousek (*loc. cit.*) has investigated very completely the poisonous effects of commercial benzol, solvent naphthas, pure benzene, pure toluene, cumene, and thiophene. Summarised, his results show pure benzene to be the most poisonous of the series, the limit of toxicity for rabbits being 0.016 parts benzene vapour per 1,000 of air. At a concentration of 0.056 parts per 1,000, rabbits suffered from severe twitching after 1 minute, convulsions after 8 minutes', deep narcosis after 10 minutes', and coma after 25 minutes' exposure. Recovery was rapid (2 to 10 minutes), and no after-effects were observed in animal repeatedly exposed. Dogs proved to be more susceptible, a concentration of 0.042 parts per 1,000 causing death in 20 minutes. Cats rank between dogs and rabbits in susceptibility. In all cases where exposure ceased before death, the recovery was rapid, and no after-effects were observed.

The occurrence of thiophene in commercial benzol suggested a similar series of experiments, and it was found that animals could tolerate concentrations of thiophene of the order of 0.03 to 0.05 per 1,000 for 1 hour without any symptoms of poisoning being detected, so that the quantity of thiophene in commercial benzol may be disregarded from a toxicological standpoint.

Toluene proved to be slower in action than benzene, narcosis being induced more gradually, whilst recovery was similarly retarded. Experiments using xylene and cumene produced similar effects, viz., slow narcosis and slow recovery. From the results obtained, it appears that the low-boiling products are rapid in action, followed by rapid recovery, and as the series is ascended, the increase in boiling point is associated with retarded narcosis and recovery.

Lehmann has shown that man exposed to an atmosphere of benzene and air absorbs 80 % of the benzene.

Carbon disulphide is used in certain quick-drying paints, and has been responsible for very numerous cases of poisoning⁹ when such paints have been used under conditions where inefficient ventilation took place. Poisoning by carbon disulphide is of a distressing and serious nature, though rarely fatal. Recovery is often prolonged, and in addition to nervous and digestive derangement, mental disturbances often appear.

The English Home Office regulations respecting the handling of carbon disulphide have been in force since 1898, but as yet are not applied to the use of paints containing this thinner, and are concerned only with its use in manufacturing operations.

Carbon tetrachloride, and the still newer chlorine derivatives of ethane and ethylene, viz., $C_2H_2Cl_4$,

C_2HCl_3 , $C_2H_2Cl_2$, C_2HCl_3 , C_2Cl_4 , are products of more recent introduction. Chemically related closely to chloroform, they all produce narcosis, though somewhat less readily than chloroform. Inhalation of the fumes results in nausea, coughing, headache and sickness, prolonged inhalation causing narcosis. The frequent presence of carbon disulphide in commercial carbon tetrachloride complicates and intensifies the dangers attendant on the use of this product. These chlorinated solvents are non-inflammable and non-combustible, and will probably find increased use in consequence of this feature.

The question of inflammability is important as increasing the risk of using some paints, and the writer's experience goes to show that much more care should be bestowed by manufacturers in the labelling of these inflammable products.

The toxic properties of volatile thinners and solvents is fully appreciated and recorded in the English Home Office official reports.¹² These reports show that such products are used in very varied trades and further that their use is attended by a certain risk. In view of this it is curious that no official warning has been issued to painters who by the nature of their employment are exposed to considerable danger.

Recently four painters were overcome by poisonous fumes from the composition they were using whilst painting the interior of a submarine at Chatham Dockyard.¹³ A contemporary, in recording this accident, states that it is authoritatively informed that in the U.S. navy such accidents are prevented by efficient ventilation and suggests that similar provision should be made in this country.

In consequence of the frequent occurrence of poisoning of this type in Hamburg, Schaefer made a full investigation of the problem, and has issued instructions and a warning leaflet to workers handling quick drying paints. Both documents are excellent in their appreciation of the position, and can be recommended with confidence to those interested.¹⁴ A similar type of instructions would be of value to the English worker, who now rarely appreciates the dangerous character of the various materials contained in paint.

Enquiries made by the writer amongst working painters elicited some very curious opinions as to the cause of occupational sickness in their trade. Many of the replies obtained showed glaring ignorance of the true causes and were surpassed only by the character of the remedies considered infallible.

In almost every case there was a definite record of severe headache attributable to turpentine vapours during the first few weeks of employment. It was stated that the headache diminishes in intensity until it occurs only when exposure to quick drying paints or varnishes is prolonged.

The dangers of using such products are reduced to a minimum in outside application, and it is the

¹² *Oil and Colourman's Journal*, 1913, 44.

¹⁴ Schaefer, (*Loc. cit.* 4), or for translation see "Industrial Poisoning," Rambousek (Legge and Arnold), London, 1913.

internal application in confined spaces which is essentially dangerous. In such cases good ventilation is absolutely necessary, and should be made compulsory.

Another factor of importance in considering sickness rates amongst painters is created by the growing tendency to consider that painting can be done by anyone able to lift a brush. This attitude has resulted in the employment of unskilled workers to a large extent. Unskilled workers are, as a rule, wholly ignorant of the properties of the products they handle—often with disastrous results.

In conclusion, it is of interest to record that recent experiments, using the leaf of the *Acuba Japonica* for the detection of vapours of the type under discussion, have proved extremely valuable, and capable of wide application. Hodgson,¹⁵ in discussing the experiments of Armstrong and Klein,⁶ states that the leaf of the *Acuba Japonica* is blackened more or less readily by lead. This is an error, and the statement cannot be found in the publication reviewed. Lead does not produce any such blackening.

¹⁵ Hodgson. CHEMICAL WORLD, 1913, Z., 292.

CHEMICAL INDUSTRIES.

A Monthly Review of the Progress of Technical Chemistry.

TREATMENT OF FOOD ADULTERATION IN ENGLAND.

By CECIL W. WOOD.

IN a recent article on "Food Adulteration in France" published in this journal, the author briefly outlined the French system of dealing with adulterations of foods and their products, and it is his intention to similarly outline the system now in vogue in England. The systems of other countries will also be dealt with as the necessary information can be accumulated. It should be borne in mind that very little attempt at treatment in detail has been intended. Those who desire further and fuller information in the case of England should consult such works as "Forensic Chemistry and Chemical Evidence," by W. Jago, and "Bell's Sale of Foods and Drugs."

Laws.—Our present system is working upon the material contained in the following laws passed during the last forty years: the Sale of Foods and Drugs Act, 1875; the Margarine Act, 1887; the Sale of Foods and Drugs Act, 1899; Fertilisers and Feeding Stuffs Act, 1906; the Butter and Margarine Act, 1907; and certain other acts of lesser importance these days owing to the fact that prosecutions under them are now quite rare, amongst which we may mention the Bread Act of 1836; Adulteration of Tea and Coffee Act, 1794; Adulteration of Hops Act, 1733; Adulteration of Seeds Act, 1869 and 1878; and the Oil in Tobacco Act, 1900.

The Collection of Samples.—Officials appointed by the Local Government Board are authorised to take samples under the existing laws for submission to the public analyst of the district for analysis. These officials are either medical officers of health, inspectors of nuisances or of weights and measures, market inspectors, or police constables employed by the local authority. These officials have powers to either purchase samples in the ordinary way from shops, or to take samples in their transit from vendor to purchaser, whilst in the case of butter and margarine they may enter factories where such articles are being prepared and take samples. Customs officials are entitled to take samples of imported goods such as tobacco and spirits without the ordinary formality of purchase. A vendor renders himself

liable to a fine not exceeding £10 on refusal to supply any such official with any particular sample demanded, after being informed that the sample is for analysis, and the same applies to anyone obstructing an official in the performance of his duty. It is the duty of the official buyer to inform the seller at the time of sale that the sample is for Government analysis, or otherwise no proceedings can afterwards be taken, and after purchase for such a purpose it is imperative that the analysis be done even in the case of the vendor admitting adulteration at the time. This, however, does not apply to private individuals purchasing an article for consumption and then afterwards instituting proceedings against the vendor. It has now been decided that these officials can also take samples by deputy, but the chief difference between official samplers and private individuals taking samples is that the latter have no powers of compulsion to make a vendor sell any special article, or even at all. As a matter of fact, however, owing to the trouble and expense involved, such prosecutions by private individuals are of very rare occurrence.

Treatment of Samples.—The most important point under this heading is the notification to vendor of intended analysis, which has been mentioned already, and the division of the sample at the time of purchase. Here again this does not apply to a person purchasing for private consumption. One undivided sample has to be divided into three separate parts, each of sufficient size to admit of separate analysis, and each part has to be marked and sealed or fastened up. One portion has to be offered to the seller, the second dispatched to a public analyst for investigation, and the third portion retained by the inspector for future reference. Where a sample is taken in course of delivery or transit it is the duty of the sampler to forward a portion of the divided sample to the person for whom the sample was intended.

The third portion of the sample retained by the inspector must be produced at the time of trial, and without this formality conviction is impossible.

Analysts and Laboratories.—The chemical specialists appointed to do analyses for the suppression of frauds are termed public analysts and they are appointed by the local authorities with the approval of the Local Government

Board, who bind them to do analyses of any sample submitted to them under the Food Laws by any public officer or private individual and to deliver a certificate on the sample in the prescribed form. According to the Regulation of 1900 as to Competency of Public Analysts, the Diploma of Fellowship or Associateship of the Institute of Chemistry of Great Britain and Ireland, together with the certificate granted by the Institute in therapeutics, pharmacology, and microscopy, is accepted as qualification.

For the analysis of fertilisers and feeding stuffs under the Act of 1906 of that name, each county borough appoints special analysts known as agricultural analysts, and a chief agricultural analyst is appointed to act as a court of appeal for the investigation of the third portion of the sample in cases of doubt.

These analysts have to provide their own laboratories and their remuneration is fixed by the local authorities. They are entitled to make use of assistants, provided that these are qualified in the work, which in its fullest sense means that they are possessed of Institute of Chemistry qualifications. One important point in which our system differs from the French is that we have no central laboratory devoted entirely to research work and the investigation and publication of standard methods of analysis for the use of analysts, but circular letters are sent out from time to time to those concerned from certain Government offices, containing advice on such subjects, though recently a large amount of research work of a diverse nature has been undertaken by the Government laboratory in addition to its ordinary work.

It might be mentioned here that such samples as are taken by the customs officials are analysed only at the Government laboratory at Somerset House and not by public analysts.

The work of the Government laboratory is extremely varied, consisting of the routine chemical work for a large number of Government departments and public bodies in addition to a number of special investigations and questions which arise annually from these departments; the examinations of samples taken by the customs and excise concerning either the assessment of duty or of drawback or with the regulations and licences relating to the manufacture and sale of dutiable articles; the examinations of samples of tea, imported dairy produce, and reference samples sent under the Foods and Drugs Act. In addition to the Government laboratory at Clements Inn and the branch laboratory at the Custom House, there are also eighteen testing stations throughout the United Kingdom for revenue purposes.

Result of Analysis.—As a result of his investigation the public or agricultural analyst is bound to deliver a certificate as a report to the public officer who collected the sample. The form of the certificate is by law to be given as follows, but it is over the question of what particulars must be furnished in the certificate that so much controversy has taken place.

FORM OF CERTIFICATE.

To ¹

I, the undersigned, public analyst for the _____, do hereby certify that I received on the _____ day of _____ 19____, from ²_____, a sample of _____ for analysis (which then weighed _____³), and have analysed the same, and declare the result of my analysis to be as follows:—

I am of opinion that the same is a sample of genuine _____.

Or,

I am of opinion that the said sample contained the parts as under or the percentage of foreign ingredients as under:—

Observations.⁴

As witness my hand this _____ day of _____
at _____ A. B.

Various opinions have been advanced as to what data should be given essentially in a certificate. Some believe that the analyst should only state his opinion and no data until requested to do so in court, for the reason that the court is usually composed of non-scientific persons, whilst other authorities say that not only the analyst's conclusions should be given but also the data by which he arrives at his conclusions, in a word, sufficient for a magistrate to act without requiring any further evidence.

Here, again, a great difference is to be noted between the French and English systems. In the French system the analyst only acts as a sort of preliminary sorting agency to detect suspected samples as a result of which chemical experts are put to work to investigate the case, whereas in the English system the analyst's certificate is more absolute and is accepted as *prima facie* evidence, and conviction may be passed on it alone in the absence of any evidence to the contrary.

Prosecution.—This is instituted by the public officer who took the sample, and information for such must be laid before a magistrate within twenty-eight days of the time of purchase. If a summons is returned this must be accompanied by particulars of the offence and a copy of the analyst's certificate.

The defendant also has the same privilege as the prosecution and may put in a counter certificate from a public analyst as sufficient evidence for the defence, and in such a case a copy of this must be sent to the prosecutor at least three clear days before the return day of the summons.

The summons is heard and decided in the ordinary way before any petty session justices assembled in the place where the sample was bought, whilst the value of the analyst's certificate as legal evidence has already been mentioned. The analyst for either party can always be called as witness, and at the request of either party the magistrate is bound to have the third reserved portion of the sample sent to the Government laboratory for confirmation, or he may do so at his own discretion.

The production of a guarantee by the defendant as to the purity of the sample when he obtained it, and also of proof that he sold it as he bought it, is sufficient evidence for the defence, but a copy of this for defence must be sent within seven days after the service of the summons.

Appeal from the sentence may always be applied for at the next general or quarter sessions or at the divisional court, according upon what fact the appeal is based.

⁴ Here the analyst may insert at his discretion his opinion as to whether the mixture (if any) was for the purpose of rendering the article potable or palatable, or of preserving it, or of improving the appearance, or was unavoidable, and may state whether in excess of what was ordinary, or otherwise, and whether the ingredients or materials mixed are or are not injurious to health.

In the case of a certificate regarding milk, butter, or any article liable to decomposition, the analyst shall specially report whether any change had taken place in the constitution of the article that would interfere with the analysis.

¹ Here insert the name of the person submitting the sample for analysis.

² Here insert the name of the person delivering the sample.

³ When the sample cannot be conveniently weighed, this passage may be erased, or the blank may be left unfilled.

Penalties.—These are paid to the authorities for the working of the Acts, and they vary in proportion to the gravity of the offence. Thus the maximum penalty for a first offence is £20, and this may be increased to £50 on second, and £100 on third offence, whilst imprisonment to the extent of three months can be imposed in certain cases. A maximum penalty of £20 can be imposed on a defendant who puts forward a false guarantee as a defence.

Statistics.—The following statistics are obtained from the reports of the Government chemist for the past four years, but classification for comparative purposes is difficult owing to annual variations in the manner of presenting the figures in the reports, whilst owing to differences of system it is not possible to give the percentage of adulterated samples of each class as were given in the article on the French system.

TOTAL NUMBER OF SAMPLES EXAMINED BY GOVERNMENT
LABORATORY AND CHEMICAL STATIONS.

	Total
1910—1911	349,277
1911—1912	345,181
1912—1913	354,759

EXAMINATIONS UNDER SALE OF FOODS AND
DRUGS ACT.

	1910—1911.	1911—1912.	1912—1913.
<i>Samples</i>	83	93	92
<i>Agreeing wholly or partially with analyst</i>	73	76	86
Percentage	87.9	81.7	93.4
<i>Disagreeing</i>	9	14	5
Percentage	11.0	15.0	5.6
<i>No certificate issued</i>	1	3	1
Percentage	1.1	3.3	1.0

Some articles on which figures for adulterated samples have been given are as follows:—

	1910—1911.	1911—1912.	1912—1913.
<i>Worts or beer in unfinished condition :</i>			
Samples	7,956	10,188	11,641
Under-declarations, percentage	15.2	20.4	17.2
<i>Beer as retailed :</i>			
Samples	7,551	7,464	9,453
Diluted, percentage	7.1	6.1	6.1
<i>Herb beers and beer substitutes :</i>			
Samples	160	444	356
Exceeding limit of spirit, percentage	3.5	32.4	24.7
<i>Beer exported on drawback :</i>			
Samples	10,710	15,389	15,628
Over-declared, percentage	0.8	1.0	0.9
<i>Beer and brewing materials for arsenic :</i>			
Samples	638	1,046	815
Above limit, percentage	6.4	1.4	1.9
<i>Fusel oil :</i>			
Samples	145	165	183
Above limit of proof spirit, percentage	2.0	3.0	4.8
<i>Tea :</i>			
Samples	10,335	12,731	10,192
Containing sand and foreign matter, percentage	6.2	8.6	9.6

	1910—1911.	1911—1912.	1912—1913.
<i>Coffee :¹</i>			
Samples	1,233	1,323	1,578
Containing chicory, percentage	0.1	0.1	0.0
<i>Cocoa and chocolate :</i>			
Samples	—	2,524	2,804
Not genuine, percentage	—	0.0	0.0
<i>Matches :</i>			
Samples	2,017	1,665	1,412
Containing white phosphorus, percentage	0.6	0.1	0.1

[¹ It should be noted that no cases of intentional adulteration were found, and that many of the samples were intended for the manufacture of caffeine.]

USE OF ORGANIC COMPOUNDS IN METALLURGICAL PRACTICE.

By GEO. PATCHIN, A.R.S.M.

UP to thirty years ago the metallurgist thought he could afford to ignore the existence of organic compounds except for the purposes of generating heat and case hardening mild steel. This erroneous idea was partly due to the semi-developed state of the "art of extracting metals from their ores" and partly to the insufficient training of those engaged in the art. The ever increasing demand, however, for high efficiency in extraction and purification, low working costs and the satisfactory treatment of certain ores and products compelled investigators to conduct their researches in a more comprehensive and impartial manner.

The object of this article is to stimulate experimental work in the use of organic compounds in metallurgical practice by a brief outline of the application, successful and otherwise, of some of these substances to this branch of industrial science.

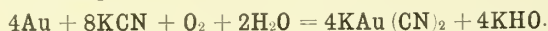
The three classes of operations chosen, viz. : extraction and purification of metals, and concentration of ores, clearly show that the use is by no means restricted.

I. Extraction of Metals.—To J. S. MacArthur and the brothers Forrest must be given the credit of initiating the use of cyanide in the extraction of gold from its ores. The fact that cyanide was capable of dissolving gold was known long before MacArthur and Forrest published the results of their labours, but little use, if any, had been made of it for that purpose. It is true, however, that in battery practice cyanide had been found useful in keeping the amalgamated plates in a clean and efficient condition, and some battery foremen had found it advantageous to feed into the battery box small quantities of cyanide for the purpose of securing good amalgamable gold. Such practices suggest that either the knowledge of the solvent action of the compound was unknown or else wilfully ignored in the gold mining centres.

That the former is the correct surmise is indicated by the paper of John S. MacArthur read before the Scottish section of the Society of Chemical Industry (March 7th, 1905), in which the author stated that in 1886 he and others were engaged in a research to find a gold solvent that would not dissolve base metals. In their investigations they decided not to consider as extracted any gold unless it was actually handled and weighed. Sulphuretted hydrogen was the precipitant chosen. Among the solvents on their programme for trial was potassium cyanide, and in November, 1886, the effect of this was tried on some tailings

from one of the Indian gold mines. As usual the resulting solution was treated with sulphuretted hydrogen for the recovery of the gold, but none whatever was obtained in this way. Eleven months afterwards MacArthur and his co-workers were apprised of the fact that the precipitant they were using did not precipitate gold from its cyanide solution. Recognising that the experiments of nearly a year before might have been successful, other ores were treated and the residues examined rather than the solutions with the result that high extractions were shown in every case. Unearthing the residues from the old experiments, to their satisfaction it was found that these also showed similar results. The author then went on to state that the guidance on the subject to be obtained from chemical and technical text-books was scanty, meagre, and sometimes misleading. They could get no information whatever on the action of cyanide solutions on gold ore and no direct or useful information as to the action of cyanide on the ores of base metals. From the foregoing it is evident that the men engaged in the industry who were using this compound in their mills were ignorant of its total effect.

The distinctive feature of the cyanide process was and is the use of very dilute solutions, stronger solutions having been shown to give inferior percentage extractions except in the case of silver ores. Oxygen is essential for the operation, the equation generally given as representing the reaction being :—



The three main operations in the process are (1) the preparation of the ore, (2) the leaching or agitation of the ore with a dilute solution of potassium or sodium cyanide¹ whereby the gold is dissolved, and (3) the precipitation of the gold followed by a smelting operation.

The mechanical details connected with these operations, the many important improvements in handling, and the introduction of new appliances come within the province of the engineer and are outside the scope of this article.

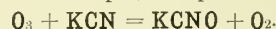
Many attempts have been made by metallurgical chemists to improve the solvent and precipitant, and reduce the cost of extraction by lessening the losses of available cyanide, regenerating the partially spent liquors and shortening the time of extraction.

An improvement of the solvent, especially on tellurides was made by Messrs. Sulman and Teed, who found that cyanogen bromide much more rapidly attacked the gold, especially in this class of refractory ores. This solvent was employed in conjunction with the Diehl Process on several of the West Australian mines and yielded satisfactory percentage extractions at reasonable costs. The Clancy cyanamide process may also be quoted to show the endeavours made in the same direction. This process was the outcome of numerous experiments on ores that were not amenable to ordinary cyanidation. By the electrolysis, in the cold, of a solution of cyanate, urea and caustic soda it was found that an active solvent for gold was produced. Similar success was obtained by the use of cyanamide in the presence of an alkaline ferrocyanide; calcium cyanamide was the particular amide used, the ferrocyanide being obtained whenever possible from the Prussian blue existing in so many of the dumps that seem suitable for profitable re-treatment. Electrolysing this mixture when in contact with the ore increased the rate of solution of the gold. Additions of sulphocyanide and an alkaline iodide increased the solvent action, the latter being found particularly beneficial in the

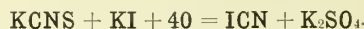
case of tellurides. Perhaps it is unfortunate that this process has been temporarily abandoned. According to an editorial in *The Mining and Scientific Press* of last May, the reason given for this is the "complications incident to most regenerative processes," but it may be that in the near future, through persistent research, this difficulty will disappear and the process become a success.

As to improvements in precipitant there is but little to refer to for zinc still has the premier place. Aluminium has been tried at Cobalt, Ontario, where silver is being extracted by cyanide solutions, and many of the initial difficulties encountered in its use have been overcome. The nearest approach to an organic precipitant is charcoal, but whether the reaction is due directly to the charcoal or to the enclosed gases is difficult to determine.²

Much more cyanide than the theoretical quantity necessary to dissolve the gold is employed in cyanidation. This is due to decomposition, oxidation, and the formation of useless and detrimental compounds. Oxidation causes a loss of cyanide by the formation of cyanate. The loss caused by ozone, for example, is represented thus :—

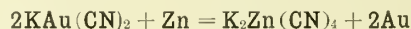


How such loss is to be avoided is a difficult problem because oxygen or an oxidising agent is necessary to obtain the solution of the gold, as already stated. It has been demonstrated, however, that sulphocyanide in the presence of an alkaline iodide tends to prevent this loss and at the same time improves the solvent by the formation of cyanogen iodide.



Much more remains to be accomplished in this and other directions before it can be claimed that the problem is satisfactorily solved.

There is also the problem of regenerating the partially spent solution. The passage of the alkali auro-cyanide through the zinc boxes results in gold being precipitated, zinc going into solution. For a considerable period the equation—



was accepted as correctly representing the reaction. In the light of later knowledge it must be taken to only partially express what happens, for whilst the analyses of the effluent from these boxes show the presence of large quantities of zinc they do not satisfy the theoretical quantity demanded by the equation.

An alkaline sulphide will precipitate the zinc, but its application on a commercial scale is not in vogue. Can some organic compound be found to precipitate the zinc and leave an active cyanide solution? Such regenerating agent must be easy to manipulate and sufficiently low in cost to make its use worth while.

From the foregoing it is evident that much has been done to utilise organic compounds for the extraction of gold from its ore, and at the same time attention is drawn to the extent of the scope for further investigation.

II. *Purification of Metals.*—Steady progress has been made in the electro-refining of metals, and in many of the bullion refineries the older chemical methods have been replaced by the electrolytic. Already with regard to this later method, there are marked indications that organic compounds are destined to play an important part.

Before dealing with this it might be remarked that in electrolytic analysis and in electro-plating organic compounds are well adapted for use as depolarising agents. Oxalic acid for instance is recommended by Classen in his

¹ At the present time sodium cyanide is invariably used in works practice.

² A paper related to this subject was read at the October meeting (1913) of the Institution of Mining and Metallurgy.

treatise on Chemical Analysis by Electrolysis. In the electro-plating industry in addition to this compound tartaric acid and cyanides have been advantageously used, and on account of its high conductivity and easy solubility in water the employment of phenol-sulphonic acid has been advocated.

In the purification of metals by electrolytic methods oxidation and polarisation have always made the work difficult. Sometimes these obstacles have been overcome by a change of electrolyte, but even then there remains the problem of obtaining a solid coherent deposit at the cathode, a matter of extreme difficulty in the case of certain metals. This subject may be conveniently dealt with under two divisions (*a*) the employment of organic compounds of the metals as electrolytes, and (*b*) the utilisation of organic substances in producing solid metal deposits.

(*a*) Organic electrolytes. These have been tried chiefly in connection with the electrolytic refining of doré bullion and lead. Up to 1885 the methods used for separating gold from silver were the acid-parting process, in which by the aid of nitric or sulphuric acid the silver alone was attacked, and the chlorine-parting process in which a stream of chlorine gas was passed into the molten bullion, the silver chloride formed floating on the surface of the unattacked gold. In the acid-parting processes a preliminary purification was usually carried out and in all cases the proportion of silver had to be above 70 per cent., whereas in the chlorine or Miller's process the gold could be in excess of the silver. Patents were taken out in 1885 for "parting" by electrolytic means and after twenty-five years the Moebius process and its modifications have largely displaced the older methods. The capacity of these electrolytic plants varies from 20,000 to 100,000 ozs. in 24 hours. The composition of the bullion is also variable, the gold being from 2 to 300 parts and the silver from 680 to 900 parts per thousand. As to the solution employed it contains about 30 gms. of silver nitrate and 10 to 15 gms. of free nitric acid per 100 c.c.; free acid is maintained in the electrolyte by regular additions amounting to 1 lb. of acid for 8,000 ozs. of doré. It should be noted that the silver deposited at the cathode by this method is spongy and bulky and has to be constantly removed by wooden scrapers or brushed off in the case where an endless silver belt is used as an electrode. Considerable experimental work has been carried out with an idea of improving both the electrolyte and the silver deposit. Betts found that silver methyl sulphate was good in both respects. By being able to make the solutions strongly acid, as in the case of the methyl sulphate, higher current densities could be employed, a point of importance because the acid solution being highly conducting the working expenses are reduced. At the same time it was found that the silver deposited from this solution was more solid than that produced from the nitrate. Amyl sulphate made strongly acid by amyl sulphuric acid was also experimented with. Whilst from the commercial standpoint these researches at present are a failure it can be claimed that the results are not without a considerable amount of encouragement and should lead to further investigation in this direction.

The first serious attempt to refine lead by electro methods was made by Keith in 1878, who used an organic electrolyte, viz., lead sulphate dissolved in sodium acetate. Nearly twenty years later Tommasi employed a similar solution in conjunction with a circular disc cathode of aluminium bronze. In each case spongy lead resulted which was scraped from the cathodes by some form of mechanical scraper. In 1901 A. G. Betts patented the use of a new solution for this purpose, namely, lead fluosilicate. The

strength of the solution varied from 4 to 20 gms. lead and 12 to 25 gms. SiF_6 per 100 c.c., but the deposit was always incompact.³ Apart from the spongy character of the deposited metal the other features were excellent, for the electrolyte possessed a very high conductivity, the saturation point was not quickly reached, and the refined lead contained only 0.0029 to 0.0139 per cent. of impurities varying according to the composition of the lead treated. This was a departure from an organic to an inorganic electrolyte, but Betts made numerous experiments with other lead salts, a large number of them being salts of organic acids. The various organic sulphonic acids were experimented with; several gave excellent results as regards the lead deposit, amongst these being phenol sulphonic, phenol-disulphonic and benzene disulphonic acids, but unfortunately many of the lead salts were too insoluble for the purpose. Lead ethyl sulphate in an ethyl sulphuric acid solution was found to have a low resistance or in other words a high conductivity and to give satisfactory cathode results, the only drawback being the deposition of a small amount of lead sulphate due to the decomposition of ethyl sulphuric acid in strong solution. It is gratifying to note that the amount deposited was not sufficient to condemn the use of this compound. Whilst it appears from the foregoing possible to use a number of organic lead salts as electrolytes the cost of the same must not be ignored, and in most instances the abandonment of work in this direction is to be attributed to prohibitive prices. If it is found possible to prepare any of the compounds mentioned, or any other compounds which fulfil the necessary electrolytic requirements, more cheaply than lead fluosilicate, the commercial possibilities are very great.

(*b*) Organic additionates. By this is meant the addition agents added to electrolytes for the purposes of producing solid deposits at the cathode. Mention has already been made of the spongy nature of the silver and lead deposits obtained during electrolytic refining. Tommasi proposed to relieve the cathode of its spongy lead by a scraper above the tank and to carry the same automatically to a press. Three years later Betts, finding that the deposit from the lead fluo-silicate solution was always incompact, did a considerable amount of work on the compacting of the separated metal by physical and mechanical methods. At first the cathodes were made of sheet iron coated with lead, the idea being to dip these when necessary or advisable into molten lead and thus melt the deposited metal off the iron. The next step was the substitution of grease for the lead plating whereby the lead peeled off mechanically. Betts, in referring to this part of the work states that "every hour during the runs, which lasted during the daytime for about a week, with a current from 120 to 150 amperes (7 to 8.8 amperes per square foot), the cathodes were taken out and passed through steel rolls of about 3 in. diameter. The sheets came through the rolls in quite a solid deposit and with a good surface. A good deal of electrolyte was squeezed out and part of this was lost, and the whole was a disagreeable job with the machinery at hand. A sample of the deposit which seemed quite solid, showed a specific gravity of 10.28 only against 11.36 to 11.40 for pure lead. This would mean a loss of electrolyte in the remaining pores per ton refined of about .3 cub. ft., still a rather serious item." After this he discovered that the addition of gelatine or pyrogallol to a fluo-silicate solution resulted in the production of solid lead deposits having the same specific gravity as cast lead. These additionates, however, did not

³ "Lead Refining by Electrolysis," A. S. Betts.

effect an improvement in the deposits when added to an acetate solution. Although not so important, another feature of interest is that although equally pure this electro-refined lead is several times stronger than ordinary lead.⁴ Considerable latitude is permissible in the amount of gelatine to be added to the solutions, thus making it possible for the ordinary workman to attend to this part of the operation. It is recommended that an addition of 0.1% of gelatine be made to a solution containing 5 to 7% of lead, but it is found that 1 part to 5,000 parts of solution (0.02%) gives equally good results. Glue, being cheaper, is the form of gelatine used, and provided the better grades are employed no disagreeable odours are to be found in the tank room. In practical work it is necessary to replenish the additivate. Under good working conditions the amount required for this purpose is small, $\frac{1}{2}$ lb. to $\frac{3}{4}$ lb. per ton of lead deposited being sufficient. This is added, a little at a time, to the solution in the circulation tank in the form of a hot strong solution. The question may arise, Does the gelatine affect the current efficiency? On electrolysis, in series, two solutions, one with gelatine and one without the same weight of deposited lead was obtained from each. Less successful results were obtained by the use of saligenin and resorcin.

The practical results of all this work are to be seen in the number of electrolytic lead refineries in operation to-day. The pioneer works is that of the Consolidated Mining and Smelting Company of Canada, Ltd., at Trail, British Columbia, with a present capacity of more than 80 tons per diem.

III. *Concentration of Ores.*—Enormous advances have been made in the concentration of sulphide ores during the past fifteen years, and in large measure this rapid progress is to be attributed to the introduction of organic agents to this class of work. Up to 1885 practically all concentration was effected by water, with a suitable machine to impart motion to the ore particles, advantage being taken of the different rate of motion between the light and the heavy minerals composing the ore. Then came the invention of Miss Carrie Everson in which a class of organic compounds, namely, certain oils, was used in conjunction with water. Her process was based on the selective action of oil for sulphides. The idea was not new, twenty-five years before Haynes had demonstrated that oily, gummy or bituminous matter had a greater affinity for metallic sulphides than for oxides and gangues. Miss Everson however developed the idea by the addition of two new features, mixing acid with the pulp followed by a thorough agitation. Her real discoveries were the increased selective action of the oil in presence of acid and the floatation of oil and sulphides after agitation. No commercial use was made of this or any of the suggested improvements until 1898, when Francis Elmore's invention took the field. Floatation was obtained in this process by oil being mixed with the watery pulp in a specially constructed drum, without emulsifying. The separation of water and gangue from oil and concentrates was made in a spitzkasten, and of concentrates from oil by centrifugating. The new Elmore process brought out in 1904 was a great advance on the earlier method. Instead of the ore being mixed with an equal weight or more of oil, only a few pounds are employed and the floatation of the sulphides secured by air released from the acidified pulp water when brought into a vacuum chamber and placed under reduced pressure. Pulp, acid and oil are agitated in a mixer and then drawn into the vacuum machine where separation of concentrates from

tailings takes place. This separating vessel is conical in shape, about 5 ft. in diameter at the base and constructed of metal, with a capacity of 30 to 50 tons per day according to the nature of the ore. The tailings pass away from an opening in the periphery of the base through a pipe which is sealed by water in the tailings tank. A series of rakes, set in such a way as to move the tailings from the centre to the periphery, slowly revolve just above the floor of the chamber, ensuring the removal of the waste material. The concentrates rise to the top of the water in the upper part of the cone in the form of a froth and pass down a concentrates pipe into another tank, this pipe also being water sealed. The oil has yet to be removed, and this is accomplished by burning off in a de-oiling oven.

It will have been noted how oil is essential in all the processes mentioned and how much therefore the metallurgist is dependent in this branch of work on organic agents. In the Elmore Vacuum Floatation Process last described a large variety of oils and similar substances have been tried and found to answer the purpose. Amongst others thus found suitable are crude oils from California, Texas, Russia, Borneo and Sumatra, blast furnace oil, tars, olive oil residues, kerosene and fish oils. About a year before the Elmore Vacuum Process was introduced, a company was formed by a number of well-known metallurgists who were vitally interested in the treatment of complex sulphide ores. This company, known as Minerals Separation, Ltd., acquired certain patents and have since been engaged in developing the same by additions and improvements. According to T. J. Hoover⁵ "the best development was the introduction, in 1905, of a method denominated . . . as the agitation-froth process, a method of floatation in which an extremely small amount of oil, less than 0.1% was added to a freely flowing pulp followed by violent agitation from 1 to 10 minutes. Innumerable small bubbles of air were thus mechanically included in the pulp which joined the oil-coated mineral particles by means of the surface tension bubbles and floated them in the form of a froth which was separated in a spitzkasten." The ore is crushed to 40 mesh, dewatered until the pulp contains 3 of water to 1 of ore, then run into a specially designed agitating and frothing apparatus, together with about 2 lbs. of oil and 10 lbs. of sulphuric acid to the ton of ore, and by means of live steam raised to a temperature of 70° C. Violent agitation and complete mixing is obtained by agitators running at a peripheral speed of 1,500 linear ft. per minute. From the mixing and agitating compartments, of which there are generally three in series, the pulp flows over a baffle to a spitzkasten, a dense froth, consisting of bubbles of gas and sulphides, rises to the surface and finally passes over one edge to a receiving launder. The tailings which also enter the spitzkasten, sink, pass out at the bottom and go to the dump or the re-treatment plant. Provided the agitating compartments are 3 ft. square, one set will treat 400 tons of ore per day. Many improvements have been made in the plant, full descriptions of which are to be found in the excellent treatise already mentioned.

A full explanation of the phenomena which make concentration possible on these novel lines must yet be sought for. Research with this end in view will probably bring to light other organic compounds that can be used in this important branch of metallurgical work and at the same time forcibly draw the attention of the embryo metallurgists to the need of a working knowledge of organic chemistry.

⁴ Betts, *Trans. Am. Electrochem. Soc.*, Vol. VIII., p. 83.

⁵ "Concentrating Ores by Floatation." T. J. Hoover, 1912.

CHEMICAL DEPARTMENT OF THE UNIVERSITY OF LEEDS.

By W. H. PERKINS, M.Sc., Assistant Lecturer and Demonstrator.

THE University of Leeds was created in 1904, on the disruption of the federal Victoria University, of which it had been a constituent College since 1887, under the name of the Yorkshire College. The Yorkshire College itself began life in October, 1874, as the Yorkshire College of Science, with three Professors, the Chair of Chemistry being held by Professor T. E. (now Sir Edward) Thorpe. It is related that on the opening day only one student appeared; but progress, if slow, was sure, and the college began its removal to the site of the present university in 1877. The Chemical Department was provided for in 1884, when it entered into possession of new laboratories and lecture theatre. The work of Sir Edward Thorpe during these years was invaluable, and when he resigned his Professorship in 1885, he left a prospering department with modern laboratories and equipment, and had laid the foundation of his reputation as the "master architect of laboratories." The only doubt expressed at first was whether the new laboratories were not too large, but the rapid influx of students which shortly took place soon convinced the doubters. Sir Edward Thorpe was succeeded by Professor Arthur Smithells, who still holds the Chair of Chemistry. During his twenty-eight years at Leeds Professor Smithells has taken part in a series of remarkable developments. A second Professorship was established in 1904 in Organic Chemistry, and to this was appointed Dr. J. B. Cohen, who had joined the staff as Assistant Lecturer in 1891. In addition to the two Professors and the Lecturer in Physical Chemistry (Dr. H. M. Dawson) there are now six other members of the teaching staff. A portion of the older university building adjoining the Chemical Department has been absorbed to provide physical chemistry



PROFESSOR A. SMITHELLS, B.Sc., F.R.S., F.I.C.

laboratories. Finally, a few years ago, when it was necessary to make immediate provision for an extraordinary growth in all departments of the university, the departments of chemistry and physics were compelled to expand into one of the quadrangles. About half an acre of land has been covered with

one-storey temporary buildings, mainly lighted from the roof, and about one-third of this extension is devoted to chemistry. Side by side with the Chemical Department, departments of applied chemistry have been established and have flourished. The department of dyeing already existed when Professor Smithells came to Leeds, and departments of leather industries and fuel industries (including metallurgy) have been established since he came, in both cases largely as a result of his remarkable power of interesting the practical man in the possibilities of scientific work in connection with industry. It is hoped that these departments will be separately described in THE CHEMICAL WORLD. Here it need only be said that the presence of their students, and of students of textile

industries, engineering, medicine and domestic science, side by side with the students of what may be contrasted be called "pure" chemistry, gives a remarkable variety to the elementary chemical teaching of the university. This teaching is carried out largely in the belief that a student makes the best progress in acquiring a fundamental knowledge of chemistry when the principles are illustrated by examples with which he is familiar, or in which he is specially interested. For this reason it is found advisable to give individual attention to students from the outset, and to select or exclude certain sections of the systematic, as distinct from the theoretical, work according to the probable after-career of the student.

The main chemical laboratory, where most students work for one and a half or two years, is devoted almost entirely to inorganic chemistry and analysis. It is a large and lofty room lined with glazed brick having bench accommodation for about 130 students. It is well provided with fume cupboards, evaporating niches, drying ovens, blast, suction, injector and muffle furnaces, etc., and distilled water and hydrogen sulphide are obtained in two small ante-rooms. The windows and fume cupboards monopolise practically all the wall space, so that the general reagents are placed on the floor of the laboratory in stands which are composed of painted iron frame work and plate glass shelves. On the same floor as the main laboratory are the professor's room, research laboratory, balance room, stores and museum, the latter being connected by a lift with the preparation room below. On the lower floor are the principal lecture theatre, a smaller theatre and the preparation room, both lecture rooms being fully equipped for the performance of experiments and the exhibition of lantern slides and specimens. There is also a combined lecture room and laboratory in which class work in practical chemistry may be freely interspersed with short lectures and demonstrations to the whole class. The two laboratories for organic chemistry, the private laboratory of Professor Cohen, and the physical chemical laboratories are on the same level. Each of the organic laboratories will accommodate twenty-four students, giving each one generous working space and room for the disposal of his now rapidly growing store of apparatus. One of the laboratories is devoted mainly to advanced and research students, the other to the more elementary work. A small balance-room and furnace room open off the latter, while a polarimeter equipment occupies a dark room in the basement. The main laboratory for physical chemistry, which has been ingeniously constructed from two smaller rooms, is provided with a large constant temperature bath, and has an efficient accumulator battery providing low potential current for electrochemical work. Smaller rooms are used

as a spectroscopic laboratory, balance room, conductivity room and lecturer's research laboratory. The basement contains a liquid air apparatus which is extensively used to supply several university departments.

The teaching of agricultural chemistry, which was formerly included in the work of the Chemical Department, is now undertaken by the Department of Agriculture, which has its own laboratories, in charge of Professor C. Crowther. Extensive developments are expected in the near future, as the university has received a considerable grant from the Development Commissioners for the study of animal nutrition.

With regard to the degrees of the university, it may be said that a four years' course is necessary to obtain an honours degree in chemistry or in any of the branches of applied chemistry, although exceptionally well prepared students may take a chemistry honours course in three years. All students taking degrees in science must at some stage in their course pass a test in the writing of English, and in the translation of passages from French and German scientific works into English.

First year students, with the exception of medicals who have a special course, attend a general course of lectures, in which the fundamental principles



PROFESSOR J. B. COHEN, B.Sc., Ph.D., F.R.S.

and facts of organic and inorganic chemistry are illustrated by a large number of experiments. An important feature is made of tutorial classes in connection with this course in which the theoretical side of the subject is dealt with in a less formal manner, and special attention is given to the working out of chemical calculations. There are two advanced courses on systematic inorganic chemistry and two on organic chemistry, as well as special courses for honours students in physical chemistry and the history of chemistry. In addition to the above, which are part of the work of all honours students, instruction is given in electro-chemistry, the chemistry of food and drugs, and chemistry in relation to public health. At some time during his course each student has the opportunity of joining a class in glass-blowing, which always rouses in him remark-

able enthusiasm for the manipulative side of laboratory work. The honours student, especially if he takes a four-years' course is always able to spend the greater portion of his last year in original work, which is everywhere becoming recognised as an important part of a degree course in chemistry. On graduation, many students take up teaching in secondary or technical schools, but an increasing number are being attracted to a year's post-graduate work in one of the departments of applied chemistry in preparation for an industrial career. The most successful remain in the chemical department for a further year's work leading to the M.Sc. degree. Of the ten honours graduates of this year, only two are not already devoting most of their time to post-graduate work. Three have remained in the chemical department, two have transferred to leather industries, one to dyeing, and one to agriculture,

department, both in the purely scientific and in the industrial periodicals.



PHYSICAL CHEMISTRY.

Flame and combustion, the nature of solutions, orientation in the aromatic series, the dynamics of organic reactions, optical activity, and the remarkable appearance of neon in vessels through which a powerful electric discharge has been passed, have formed the subjects of some of the more important papers published from the department. The atmosphere of Leeds has provided an excellent medium for the study of the effect of smoke and products of combustion. At present a thorough and systematic survey of the various mineral springs at Harrogate is being carried out and is providing problems of considerable interest for various members of the staff. The teaching and research staffs of the various departments of applied chemistry and of physics now number nearly fifty, and a weekly scientific colloquium provides them with an opportunity to meet and discuss their own and other recent researches. This gathering is remarkably successful, and some



INORGANIC LABORATORY.

and one has gained an appointment on the chemical staff of another university. There has always been a steady output of published work from the chemical

of the discussions have been of very great value. The physicists, in particular, are always interesting and suggestive in their criticisms of chemical problems. The students have their own society, appropriately named the Cavendish Society, since,

period has been reached in the production of the Catalogue of Scientific Papers. Since the year 1901 the sum of £21,151, mainly contributed by the late Ludwig Mond, has been expended; only £190 is available at the present time.

The attention of the Treasury is being drawn to the fact that the National Physical Society Laboratory is being handicapped for want of funds, and that a great deal of useful work is delayed as a consequence.

The following officers and council of the Faraday Society have been elected to serve for the year 1913-14: *President*: Sir Robert Hadfield, F.R.S. *Vice-Presidents*: G. T. Beilby, F.R.S., Professor K. Birkeland, W. R. Bousfield, K.C., Professor Bertram Hopkinson, F.R.S., Professor A. K. Huntington, T. Martin Lowry, D.Sc., Alexander Siemens, M.Inst.C.E. *Treasurer*: F. Mollwo Perkin, Ph.D. *Council*: R. Belfield, Dr. H. Borns, W. R. Cooper, Professor F. G. Donnan, F.R.S., Emil Hatschek, Dr. R. S. Hutton, Professor Alfred W. Porter, F.R.S., E. H. Rayner, Dr. R. Seligman, Maurice Solomon.

The third International Congress of Tropical Agriculture will be held in 1914. It will open on June 23rd, and be held at the Imperial Institute. Communications for the Congress, which may be made in English, French, German, or Italian, may be sent to the Organising Secretaries at the Imperial Institute. The subscription for membership is £1.

In their report the Departmental Committee dealing with the storage of celluloid make certain important recommendations, but do not propose that these shall extend to retail shops. The cinematograph trade is considered separately.



ONE OF THE ORGANIC LABORATORIES.

though mainly chemical as regards numbers, it is again a meeting ground for members of all the departments of chemistry with those whose main interest is physics. Here, of course, discussion is not so plentiful, but the meetings have a distinct value both from the social and the scientific side.

PERSONAL AND OTHER NOTES.

SIR ARCHIBALD GEIKIE announced, at the annual meeting of the Royal Society, that Sir James Caird had placed at the disposal of the Society the sum of £5,000, to be applied to the encouragement of physical research.

Under the will of the late Mr. William Weir a sum of £5,000 is left to the building fund of the Royal Technical College, Glasgow, and a similar sum to the University of Glasgow.

The National Physical Laboratory announces that the Laboratory is prepared to test samples of radium and mesothorium preparations by comparison with the British Radium Standard, which has been certified by the International Radium Standards Committee after comparison with the International Standard at Sèvres. The duration of each test will extend over ten days; and if the specimen proves to be in radio-active equilibrium, a certificate will be granted giving its equivalent metallic radium content, providing that this is in excess of 1 mg. The scale of charges ranges from three to seven guineas per sample.

The Council of the Royal Society report that a critical

NOTES OF MEETINGS.

Chemical Society.

January 22nd, 1914.

Society of Chemical Industry.

LONDON SECTION.—January 5th. Viscosity of Oils, by J. L. Stevens; Oxygen Content of Gases from Roasting Pyrites by Lewis T. Wright.

NEWCASTLE SECTION.—January 13th.

YORKSHIRE SECTION.—January. Corrosion by Dissolved Oxygen, by Messrs. Cobb & Dougell.

Royal Institution.

January 23rd. Sir J. Dewar, "Coming of Age of the Vacuum Flask."

Institution of Civil Engineers.

January 13th, 20th and 27th. Ordinary Meetings.

Institution of Mechanical Engineers.

January 16th. General Meeting.

Institution of Electrical Engineers.

January 8th. "The Development of Electric Power for Industrial Purposes in India," by H. R. Speyer.

January 22nd. The Fifth Kelvin Lecture, by Sir Oliver Lodge, F.R.S.

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

CHAPTER I.

INTRODUCTION.

IT is a matter of common observation that many chemical reactions which normally proceed slowly, often so slowly as to be overlooked, can be accelerated to a greater or less degree by the introduction of some foreign material. The importance of this phenomenon—defined as far back as 1835 by Berzelius, as *catalytic*—will be at once evident, for by means of it, the technologist is able to effect readily reactions which would otherwise be either impracticable or impossible. More than a dozen years ago, Ostwald predicted that the great advances of chemical industry would be made through the more extensive employment of catalytic means, and his words have already found ample fulfilment in the establishment of new industries, as well as the further development of the old. The attention which the subject is receiving nowadays at the hands of industrial chemists justifies a hope of still more valuable application in the future.

GENERAL CONSIDERATIONS.

Before defining the term *catalyst*, the general question of reaction velocity demands attention. Reactions may be roughly divided into two classes: (1) those termed "ionic," which are practically instantaneous reactions; and (2) those which, like the saponification of fats, take an appreciable time to attain equilibrium. Obviously, catalytic phenomena are concerned only with the latter, and particularly with that section of them which proceed so very slowly that no reaction appears to be taking place at all.

Now, the velocity of a reaction may be expressed in the following terms:—

$$\text{reaction velocity} = \frac{\text{chemical force}}{\text{chemical resistance}}$$

from which it follows that any alteration in chemical force or chemical resistance will correspondingly affect the reaction velocity. Thus, since rise of temperature both increases the chemical force and decreases the chemical resistance, the reaction velocity will be appreciably increased, which is in accordance with the general observation that a rise of 10° C. in the temperature usually more than doubles the velocity of the reaction. Increasing the viscosity, on the other hand, by increasing the chemical resistance decreases the reaction velocity, as exemplified by Raschig's recent method for the manufacture of hydrazine, where the velocity of one of two simultaneous reactions is so reduced that a large percentage yield of the product of the other reaction can be obtained.

Again, the law of Mass action, according to which the reaction velocity is proportional to the concentrations of the reacting bodies, suggests another means for adjusting the reaction velocity, viz., by variation of the respective concentrations. Still other factors, such as light, pressure, etc., are available for the same purpose.

The employment of any of these factors, however, is not generally advantageous. Increase of temperature is often injurious in technical processes, whilst the influence of the remaining factors is usually so small as to be almost negligible. Other means of diminishing the chemical resistance, preferably without increasing the chemical force by the expenditure of energy, are therefore desirable, and it is here that the full utility of catalysis appears. In the following pages many examples will be brought forward of an impractically slow reaction which has been found to be capable of acceleration to the point of commercial success, without the expenditure of energy and at ordinary temperatures, merely by the assistance of a catalytic means.

Of the many definitions of the term *catalyst* and their respective merits, it is impossible to speak here. Ostwald's definition, which, by reason of its authoritativeness, has obtained general acceptance, states that "a catalytic agent is that material which affects the velocity of a chemical reaction without appearing in the final products." The definition, though open to objection on several grounds, may at least be accepted as setting forth the two main criteria of a catalytic process. These and other characteristics will now be discussed, together with considerations that arise therefrom.

CHARACTERISTICS OF CATALYTIC REACTIONS.

(1) NEGATIVE CATALYSIS.

From the definition given above, it is evident that the effect of a catalyst may be either positive or negative, *i.e.*, the catalyst may either accelerate or retard the reaction. Practically all catalysts fall into the first or positive class, but there are a few which effect what is known as *Negative Catalysis*. The phenomenon is to be observed in the case of a substance which is added to another to preserve it; or in the oxidation of sodium sulphite, where the presence of certain organic compounds in small quantities enormously reduces the rate of attack (Bigelow). Another interesting example is to be found in the observation that '2% moisture in pure fulminate of mercury so alters the speed of decomposition that what ought to be a detonation becomes merely an explosion (Orsman).

When carefully differentiated, however, from the paralysing effect which certain bodies exert upon

positive catalysts, the importance of negative catalysis dwindles to insignificance.

(2) UNCHANGEABLENESS OF THE CATALYST.

That the catalyst has the same chemical composition at the beginning as at the end of the reaction, is undoubtedly the most important characteristic of catalytic phenomena. Often the catalyst is known to participate directly in the reaction, but in these cases, though the equations of the intermediate stages involve the catalyst, the gross equation must not.

Occasionally, the catalyst is found to emerge from the reaction in an altered *physical* state. Thus, the crystalline variety of manganese dioxide, used as a catalyst in the decomposition of potassium chlorate, finishes as a fine powder, and a similar curious alteration is found in the oxide of iron employed in the Claus furnace and the platinum of the Sulphuric acid process. It appears necessary in these instances for the catalyst to mature before attaining its maximum activity, this "ageing" consisting most probably of a physical devolution into a fineness of division greater than can be obtained by mechanical means. It must be noted, however, that the variation of energy produced by the change can hardly modify the reaction to any extent.

(3) AMOUNT OF CATALYST NECESSARY.

(a) *The Amount must be Small.*—In catalytic reactions, only a trace of the foreign material is sufficient to effect the transformation of indefinitely large quantities of the reacting substances. For example, .0004 gr. of colloidal platinum will bring about the combination of 10 litres of hydrogen and oxygen without the activity of the catalyst being impaired (Ernst). This necessity for a mere trace of the added material constitutes one of the important characteristics of catalytic reactions.

There are instances in which the solvent, a third and unchanging body, varies the velocity of the reaction between two substances dissolved therein, and these would therefore fall within the purview of our definition, unless, as should be the case, exception were taken to them on the ground of the large amount of the third body necessary.

(b) *The Amount remains Constant.*—Unless side reactions interfere, the quantity of the catalyst remains unchanged. Of course, in practice, renewal of the catalytic agent at intervals is necessary, largely on account of deterioration consequent upon the accumulation of "poisonous" material, of which more will be mentioned later.

Instances of true catalysis, however, are known, in which the catalyst either increases or decreases in quantity as the reaction proceeds, the apparent contradiction arising from the fact that the catalyst is set free or absorbed by the reaction itself. The phenomenon is known as *Autocatalysis*, and an example is found in the hydrolysis of an ester by water, where the liberated acid acts as the catalyst.

At this point, it is convenient to refer to the large and interesting class of chemical reactions known as *Induced Reactions*, in which a slow reaction between two substances is accelerated in the presence of a simultaneous rapid reaction between one of the reacting bodies of the first reaction and a third body. For example, a solution of sodium arsenite when shaken with air undergoes no change, whereas sodium sulphite similarly treated is rapidly oxidised. If now a mixture of sodium sulphite and sodium arsenite in solution be shaken with air, both salts are oxidised. In other words, the oxygen of the air is activated to a sufficient extent to attack sodium arsenite by the mere presence of a varying quantity of sodium sulphite. The third body, in this case sodium sulphite, therefore acts in a manner which suggests catalysis, even though its quantity throughout the reaction is a diminishing one. For a complete discussion of this class of reaction, the reader is referred to Skrabal's "Die induzierten Reaktionen" in the *Sammlung chem. und chem.-techn. Vorträge*, Bd. 13, p. 321.

The mention of other classes of reactions bordering upon the catalytic, raises the question as to the exact line of demarcation between catalytic and non-catalytic processes. As a matter of fact, it is very difficult to draw such a line. In cases of doubt, it is well to fall back upon the definition, and failing that, upon the characteristics now under discussion. The Weldon process, for instance, would be relegated to the class of *False Catalysis*, for though the lime employed apparently plays the part of a third and necessary agent, yet it becomes transformed during the process, and thereby transgresses the definition. The preparation of nitro-glycerine, again, involves a reaction which comes even nearer the truly catalytic, since the successful nitration of glycerine certainly requires the presence of concentrated sulphuric acid, which latter emerges from the reaction chemically unchanged. The reaction might, therefore, be held to fall within the scope of our definition, but would still not be admitted to the class of true catalytic reactions by reason at least of the amount of third substance required.

(c) *Proportionality between Amount of Catalyst and the Reaction Velocity.*—As a rough generalisation, it may be stated that the activity of a catalyst is directly proportional to its concentration—a relation that would not be unexpected, seeing that the great majority of catalytic processes are monomolecular reactions. In some cases, nevertheless, the relation between the velocity constant at a particular temperature and the concentration of the catalyst is not a linear one.

(4) INCAPACITY OF CATALYST FOR STARTING A REACTION.

Among chemists and physicists, the question as to whether or not the catalyst is capable of starting a reaction is still a moot point. There are many who carefully differentiate catalytic reactions from what are called "trigger actions," meaning by the latter

term reactions which cannot take place unless released, or their chemical forces unloosened, in some way.

This distinction will be best brought out by a mechanical analogy. Imagine a sheet of material inclined at such an angle that a weight can just slide slowly down. Now grease the bottom of the weight and the rate of fall is greatly increased. The grease then acts in an analogous manner to a catalyst, its influence being proportional within limits to the amount of it used. If, however, the weight be held at the top of the incline by one or more catches, the rate of fall of the weight is quite independent of the number of catches, being always the same. We have then an analogy with "trigger reactions," of which the crystallisation of supersaturated solutions is a good example. The crystallisation of such a solution has been shown to be independent of the amount of crystal with which it is inoculated (Moore), and on this ground, has been refused inclusion with catalytic processes.

Difference of opinion is mainly concerned with those reactions, such as that between hydrogen and oxygen, which do not appear to take place at all under ordinary conditions unless a catalyst is present. Ostwald regards such reactions as infinitely slow under these conditions, arguing that since the reaction does take place at high temperatures, and as the velocity becomes progressively slower with diminution of temperature, it is reasonable to infer that a very slow reaction velocity could exist even at ordinary temperatures. The fact remains, nevertheless, that this velocity is too small to admit of measurement by present-day methods and apart

from the above reasoning, therefore, experiment would lead us to believe that catalysts are capable of initiating reactions.

(5) EFFECT UPON THE FINAL STATE OF EQUILIBRIUM.

The difference in the energy equations of the initial and final states of a reaction represents the amount of energy transformed, and since a catalyst introduces no energy, it follows that the final state of equilibrium must remain unaffected. Otherwise, of course, by permitting the reaction to take place alternatively with and without the assistance of a catalyst, energy could be generated and a perpetual motor established.

Again, the final state of equilibrium of an inverse reaction depends only upon the ratio of the velocities of the two inverse reactions, and since this final state has been shown above to remain unaltered by the introduction of a catalyst, it may be deduced that the catalyst affects the two reaction velocities to the same extent, in order to keep their ratio constant.

As a further deduction from the same statement that the final state of equilibrium is independent of the catalyst, it may be observed that the state of equilibrium is independent of both the reaction and the quantity of the catalyst. Thus, in the case of the contact process for sulphuric acid, it is not the equilibrium, but only the velocity of its attainment which is affected by the use of vanadium pentoxide or ferric oxide instead of platinum.

(To be continued.)

RECENT PROGRESS IN SAMPLING AND TESTING FUELS.

By JOHN B. C. KERSHAW, F.I.C.

(Continued from page 388.)

(D) *A large municipal electrical supply works in the north of England.*—The borough electrical engineer reports that tenders are invited for fuel to a specification which records the minimum calorific value of the fuel and the maximum percentage of ash. When the tenders are received, certain fuels are picked out for testing purposes. A sample lot of 100 tons is asked for (this is equal to one day's supply), and the whole of the works is then run on this sample lot, and the amount of fuel per unit, cost per unit, and percentage of ash made, is carefully noted. In addition to this practical test, a laboratory test is made from a sample sent to an analytical chemist. The contract is then placed with the firm whose sample of coal shows the best result per unit generated.

Regular analytical tests of the fuel are made during the year's run and the contract includes a clause stating that in the event of the fuel not coming up to the guaranteed calorific value it may be rejected and the contract be cancelled.

(E) *A large cotton spinning company, with a mill, in the Manchester district.*—This company managed to obtain (in 1908) a contract with a Lancashire colliery company on the sliding scale basis; but after two years' trial the contract was not renewed, owing to the objection of the colliery company to its terms, and to their refusal to be bound by them, even when the fuel supplied was better than that contracted for, and the price variation was in their own favour.

While this contract was running, two carefully prepared average samples were tested per month by an independent analyst. These samples showed a striking uniformity in ash contents and calorific value, the variation from the calorific value of the sample upon which the contract was based being well within 5% for the whole of the period. This uniformity in the heat value of the coal actually delivered was, no doubt, largely due to the knowledge that the coal was being regularly sampled and tested at the consumer's works.

The consumers recognised this fact themselves, and stated in a letter to the writer that "we are greatly in favour of the system of purchase upon calorific units. Since our contract of December, 1908, when we began the new system, we have had a much more uniform fuel supplied to us, which is all we aimed at."

(F) *A flour-milling company, with several mills, in south-west Lancashire.*—This company, like that cited above, found a firm of colliery proprietors willing to close a contract on the sliding-scale basis.

The experience of the second firm, however, has been rather different from that of the first, since marked variations occurred in the quality of the fuel supplied, and in consequence there were considerable reductions made in the price paid for the fuel. It is noteworthy that the largest increases in ash, and corresponding decline in calorific value, occurred during the second half of the year 1909, although the coal merchants declared they were supplying exactly the same fuel as in the earlier months. This falling off in the quality of the fuel contracted for, lends support to the assertion that the operation of the Mines Eight-hours Act has affected the quality of the small coal raised and sold in certain mining districts.

In this case also the sliding-scale arrangement ceased at the end of 1910, owing to a change of management at the mill and the appointment of a manager who did not believe in the value of laboratory testing of fuel.

In conclusion, the principal features are given below of a *standard coal specification* and of the *conditions of contract* for the purchase of coal by electricity works, agreed upon by a committee representing the principal London firms of coal contractors on the one hand, and a committee representing the Associated Municipal Electrical Engineers of Greater London, on the other. The former committee included Mr. G. C. Locket (chairman of Messrs. Gardner, Locket, Hinton & Co., Ltd., and chairman of the London Society of Coal Merchants); Mr. C. Fitzstephen Corr (of Messrs. Stephenson, Clarke & Co., Ltd.); Mr. John Robertson (of Messrs. Hudson & Co., Ltd.); Mr. W. Valder (of Messrs. Wm. Cory & Son, Ltd.); and Mr. C. McRea (of Messrs. J. H. Beattie & Co., Ltd.). The municipal engineers committee comprised the electrical engineers of Poplar, Stepney, Finchley, Shoreditch and Hornsey, and was representative of Greater London generally.

Two model specifications were drawn up, the first being for a coal of a particular description or "named" coal; while the second was for a coal guaranteed to possess certain definite physical and chemical qualities. The principal features of this latter specification for "guaranteed coal" are as follows:—

The tenderer shall set out in his details the classes of coal for which he is tendering, corresponding with the classes referred to in the table of standards.

Sampling.—(A) A representative sample shall be

taken on delivery from each or any consignment, and shall be divided and sealed in three air-tight vessels. The contractor shall be at liberty to be represented when the sample is taken and shall be entitled to one portion thereof; but he shall have no opportunity at a later date of objecting to the manner in which the coal has been sampled.

Testing.—(B) Samples taken in the manner defined shall be taken from each consignment and tested by the purchasers, or in the event of a dispute, by a competent expert, who shall be approved from time to time by the purchasers, and whose fees shall be paid by the contractor, if the purchaser's test is confirmed. The tenderer is invited to set out in the tender's details, the names of three experts either of whom he is agreeable shall be employed. A table of standards is then given for application in connection with guaranteed coals. As regards the methods of testing the fuel the following conditions are laid down:—

British thermal units shall be ascertained, on coal dried at 220° F. for an hour, by means of a Mahler bomb calorimeter. Moisture shall be represented by the total loss in weight of the coal delivered after air drying and exposing to a temperature of 220° F. for one hour. The percentage of sulphur shall be based on the analysis of the coal "as received," and must not exceed 2%. The sieves used for determining the percentages of "small," shall be of square mesh, with openings in the clear to the sizes given.

The United States.—The scientific control of fuel supplies has obtained its widest application in America, a result due partly to the fact that the Government in that country has taken up vigorously the system of purchasing fuel on a heat-unit basis, and partly to the greater readiness of American business men to give science its proper place in the control of industrial and manufacturing operations.

Across the Atlantic the fact that a method is *new* and that it cuts across established customs and methods of business is no bar to its trial; whereas on this side of the "herring pond" it takes years of education and effort to arrive at the same standpoint.

The most recent figures available relating to the adoption of scientific control in U.S.A. are contained in an article by Loeb published in the *Engineering Magazine* of March, 1911. The annual value of the fuel consumed for industrial and other purposes in U.S.A. is there stated to be \$1,360,000,000, the tonnage being 528,000,000. The Government purchases annually coal to the value of \$7,000,000. Half of this is used by the Navy Departments for war vessels, and is purchased on a British thermal units basis, a premium being paid for all coal showing more than 15,000 B.T.U. in the dry state. No wet coal is accepted. The balance of the Government's annual coal purchases is bought on a *pro rata* "as received" British thermal unit basis, and the seller is also penalised to the extent of from 2 cents to 35 cents per ton, for variations in ash rising from 3% to 9% above the guaranteed amount; 2% above the guarantee being allowed to

pass without fine. The method of sampling and of calculating the heat value is as follows:—

In all cases, where practicable, the coal is sampled during its discharge into the building where used. The sample selected in no case is less than 100 lbs. and is reduced by repeated crushings and quarterings to the small amount required for testing by the Treasury Department. The method of analysis and of calorific valuation is that drawn up by the American Chemical Society.

Payment is made upon the basis of the price named in the proposal for the coal specified by the seller; correction being made for the variation in ash and heating value. For example, if the coal contains 2% more or less British thermal units than the standard named in the specification, the price is increased or decreased in the same proportion.

The price is also corrected for the percentage of ash, and for all coal which contains less ash than the standard named in the specification a premium of one cent per ton is paid for each 1% of ash. An increase of 2% of ash over the standard named in the specification, on the other hand, is not weighted with a penalty; but above this limit a deduction is made from the price paid for the coal. The coal is to be weighed as delivered, and as payment is made upon this delivery weight, the calorific test is made upon the coal containing whatever moisture may be present at the time.

The *Fuel Engineering Co.*, of Chicago, is an independent sampling and testing organisation with a large number of clients who purchase fuel on a British thermal unit basis, and hand over all the scientific work required in connection with this method of purchase, to the officers of the company. The company publishes a monthly test sheet for circulation amongst its clients, giving details of all the tests made during the previous month. Much valuable information concerning the comparative heat value and price of the fuels marketed in Chicago, thus becomes the common property of all who have regular tests made of their fuel deliveries by this organisation, and each consumer finds out quickly if he is obtaining a good return for his expenditure upon fuel. The specification and method of regulating the price by the quality, used by the *Fuel Engineering Co.*, of Chicago, is rather more complicated than that used by the U.S.A. Government departments, and is based upon what is called the contract guarantee, or number of British thermal units which are obtainable for 1d. (2 cents) from the trial sample of the fuel.

The *Interborough Rapid Transit Co.* is a private electric tramway company, which consumes annually 360,000 tons of a bituminous "run of the mine" coal. This is purchased upon a British thermal unit basis of 14,100, with limiting values for ash (9%), sulphur (1.5%); variations above or below these figures are subject to deductions or premiums as the occasion demands.

The coal for the *Panama Canal constructional works*, which amounted to 650,000 tons per annum, has also been purchased on a British thermal unit

basis of 14,600 (as received) with deductions for variations below this limit.

The *Department of Water, Gas and Electricity Supply for New York City* uses a very large quantity of coal per annum, and the issue of *Power* for February 27th, 1912, contains details by Hutton and Pulz of the system of purchase, which is considered by its authors to be an improvement upon the system used by the U.S.A. Government.

Before drawing up definite specifications a careful investigation was first made of the character of the various coals furnished in the buyer's area, and from these results a diagram was plotted as respects the moisture, ash, volatile sulphur and combustible matter. Any coals falling within the limits so outlined were put in the list of eligibles as to quality, or as not open to a penalty. Coals lying outside these limits and below them would be penalised with respect to weight but not as to price, so that the buyer should not buy water or incombustible mineral matter and pay for them at the rate agreed on for good coal. The research developed the relation that each percentage of ash in the coal, besides displacing 1% of combustible matter, had a retarding effect varying with the quality of the coal equivalent to a withdrawal of between 145 and 155 B.T.U. with an average of 150 B.T.U. With this as a basis, a formula was evolved applicable both to anthracite and bituminous coal in the following form:—

Corrected tonnage = tonnage delivered multiplied by

$$\frac{(\text{B.T.U. per lb. as delivered} - 150 \text{ B.T.U. multiplied by excess percentage of ash})}{\text{B.T.U. per lb. as specified in standard analysis.}}$$

For practical purposes the formula can be simplified by using a direct percentage relation, whereby 1% in weight shall be deducted for each 100 B.T.U. and an additional 1% for each percentage of ash. This can be equally well applied when it is desired to give a bonus. The weight of the coal after correction for moisture is then reduced at the rate of 1% for each percentage of ash in excess of that permitted by the standard, and the gross dry weight after correction for moisture, at the rate of 1% for each 100 B.T.U. below the standard heating value. The gross dry weight is also corrected at the rate of 5% for each 1% of volatile sulphur in excess of the standard. These corrections are then aggregated and deducted as a whole, payment being made only for the balance of the gross weight, at the price bid per unit furnished, delivered and stored and trimmed (if so specified in the schedule).

These examples will show that purchases on a British thermal unit basis is the rule rather than the exception with large fuel users in U.S.A. and that there are many different ways in force of carrying this out.

As proof of the interest taken in the subject of fuel sampling and testing in the States, the publications of the Bureau of Mines at Washington, may be referred to. The following list of Bulletins is by

no means complete, but it shows how well the subject has been covered:—

1908. Bulletin 339. "The Purchase of Coal under Government and Commercial Specifications on the Basis of its Heating Value."
Bulletin 362. "Mine Sampling and Chemical Analysis of Coals tested at the U.S. Fuel-testing Plant, Norfolk, Va."
1909. Bulletin 378. "Results of Purchasing Coal under Government Specifications." 1907—1908.
1910. Bulletin 428. "Results of Purchasing Coal under Government Specifications." 1908—1909.

New Series.

- Bulletin 27. "Tests of Coal and Briquettes as Fuel for House-heating Boilers," by D. T. Randall. 44 pp., 3 plates, 2 figs.
Bulletin 28. "Experimental Work conducted in

the Chemical Laboratory of the United States Fuel-testing Plant at St. Louis, Mo., January 1st, 1905, to July 31st, 1906," by N. W. Lord. 51 pp.

- Bulletin 41. "Government Coal Purchases under Specifications, with Analysis for the Fiscal Year 1909-10," by G. S. Pope, with a Chapter on the Fuel-inspection Laboratory of the Bureau of Mines, by J. D. Davis. 1912. 97 pp., 3 plates.
Technical Paper 1. "The Sampling of Coal in the Mine," by J. A. Holmes. 1911. 18 pp., 1 fig.
Technical Paper 8. "Methods of Analyzing Coal and Coke," by F. M. Stanton and A. C. Fieldner. 1912. 21 pp., 5 figs.
Technical Paper 26. "Methods of Determining the Sulphur Content of Fuels, especially Petroleum Products," by I. C. Allen and I. W. Robertson. 1912. 13 pp., 1 fig.

NOTES ON CHEMICAL ENGINEERING.

By J. W. HINCHLEY, A.R.S.M., WH.Sc.

CHAPTER V. (*continued*).

THE blending of greases, butter, margarine, etc., is generally carried out in butter workers, the usual type being shown in Fig. 57. For this class of work, the fluted roller and bed of the machine are made of hard timber, beech by preference, and the rusting of the iron framework supporting the bed is prevented by cementing the timber to it by means of asphalt. Other butter workers, or kneading machines are provided with double worms which force the material after kneading through

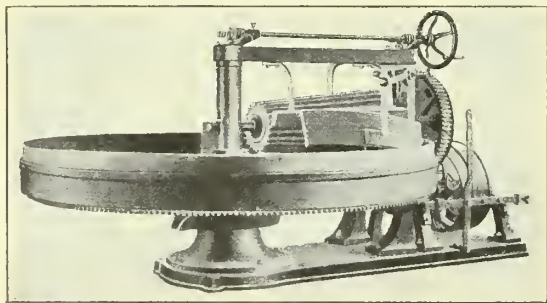


FIG. 57.—BUTTER WORKER.

dies of suitable form for making cakes. Such machines are called plodding machines, and in many factories the ordinary "Enterprise" meat chopper is adapted for this work by modifying the die plates. With stiff plastic material hydraulic presses are often used to force the material through a screening surface and through die plates having small holes. Immediately under the die plates a revolving cutter divides the sticks into small pieces, which are then

thoroughly mixed in a mixing machine and again consolidated in a suitable press. A mechanical press for consolidating such stiff materials is shown in Fig. 58. The material is fed into the machine slowly and at each stroke of the piston A, a hammer

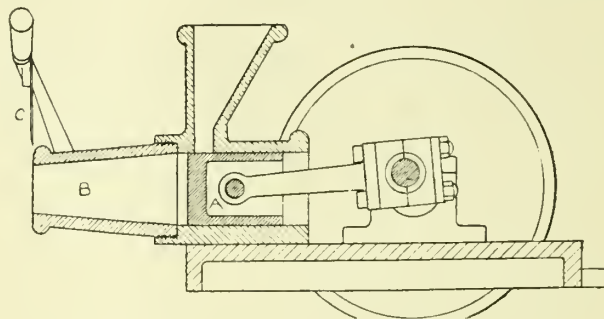


FIG. 58.—CONSOLIDATING PRESS.

blow consolidates the material and forces it through a taper nozzle B, while the imprisoned air escapes on the back stroke of the piston. The cakes of material are cut off at suitable intervals by the knife C. This machine has been modified for hydraulic pressure, and by connection with a vacuum pump at each charge the imprisonment of air in the material is prevented.

For the stiffest masses, mixing is most readily accomplished by means of rolls, Fig. 59. These revolve in opposite directions at unequal speeds, and continually knead and masticate the material. This is the standard machine of the rubber and celluloid industries. To facilitate the work the rolls are often steam-heated, especially when sol-

vents are associated with the material, which must be driven off. The surface speed of these rolls is about 120 ft. per minute, and the difference in speed is usually small. When the rolls run at equal speed, the time required for mixing is rather great and when the difference in speed is great, the material is torn and not consolidated so that its strength is reduced largely on account of a lack of homogeneity. A difference of from 5 to 10%

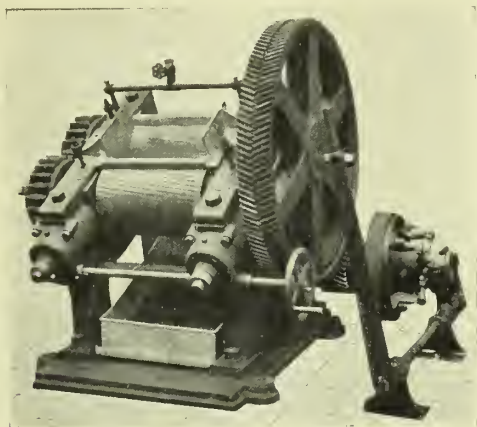


FIG. 59.—MINING ROLLS.

appears to be satisfactory in most industries. When working plastic mixtures made with solvents, the rolls are at first kept near together, and are opened as the mixing proceeds and the stiffness increases, the rate of evaporation of the solvent diminishing as the thickness on the roll increases. The material tends to adhere to the fastest roll and with many plastics forms a tube on this roll, which by being cut longitudinally may be removed from the machine as a sheet ready for the moulding processes.

CHAPTER VI.

THE TRANSPORT OF SOLID MATERIALS.

THE common wheelbarrow is most extensively used in chemical factories for transport purposes where changing conditions or occasional use renders the installation of conveyors or tramways unremunerative.

An ordinary labourer can transport .5 ton of material per hour per 100 yards, so that the cost of such transport will be 8d. to 10d. per ton per 100 yards. In rapid working the barrows are filled by a shoveller and trundled by a wheeler; the proportion of wheelers to shovellers is estimated for earth-work by the fact that a shoveller can fill a barrow in about the same time as a wheeler can wheel it 30 yards, tip it and return with the empty barrow; 1 yard of rise is usually taken as equivalent to 6 yards in horizontal distance. An iron plateway should be laid where much barrow work is done, both to ease the work and to reduce the road repairs.

Trucks with two wheels, on which the load is practically balanced, are more suitable for heavy loads, especially where iron plate tracks are pro-

vided. Light four-wheeled waggons provided with tyres suitable for plateways or railways are, however, more generally efficient. Such railways are supported overhead for charging furnaces, etc., and the waggons are pulled by means of an endless cable.

The tractive effort required for pulling such trucks on a level is usually estimated at 30 lbs. per ton of total load. Runways, *i.e.*, overhead rails carrying a small trolley which is provided with a hook from which a skip is suspended, are also of great utility for charging purposes, and are both inexpensive in first cost and in working.

When horses are employed in hauling waggons one horse may be expected to transport 8 tons at the rate of $3\frac{1}{2}$ miles per hour on rails, and from 1 to $1\frac{1}{2}$ tons on ordinary level roads.

Continuous Transport of Materials.—The continuous transport of materials is accomplished by

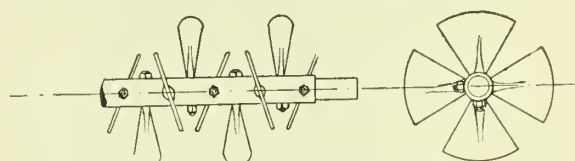


FIG. 60.—PADDLE TYPE OF WORM.

conveyors, which may be classified as screw, scraper, band, vibrating and bucket conveyors.

The screw or worm conveyor consists of a trough containing a rotating screw by which the material is pushed along the trough. The lid of the trough is left loose so that in case of choking the lid lifts and the screw is not damaged. The material is delivered through an opening at the bottom of the trough near the delivery end. A certain amount of mixing takes place in such conveyors, and in some instances this feature is very valuable. In the paddle type of worm (Fig. 60) the helix is formed by bolting blades of suitable section to the driving shaft. Cast-iron worms are made in sections (Fig. 61), which are threaded and fixed on the central shaft to form a continuous helix. Wrought-iron or mild-steel worms are made in several ways; in the most recent forms the thread of the worm is rolled from a flat strip of metal into a spiral form, and fixed in a groove cut in the central shaft. In the ribbon or spiral conveyor (Fig. 62) the worm is supported at a few points on the shaft as shown.

These worms rotate in troughs of wood or metal, with a clearance of from $\frac{1}{8}$ to $\frac{1}{4}$ in. The distance apart of the bearings depends on the stiffness of the

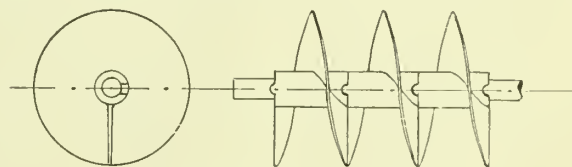


FIG. 61.—CAST-IRON WORM IN SECTIONS.

worm, and varies from 8 ft. for 4-in. worms to 12 ft. for 12-in. or larger worms. A total length of 100 ft. is usually considered as the practical limit on account of the torsional stresses in the shaft. The pitch of

such worms varies from one-third of the diameter for heavy materials to the diameter for light materials, but for most materials a pitch equal to half the diameter of the worm gives satisfactory results.

The peripheral speed of worm conveyors depends

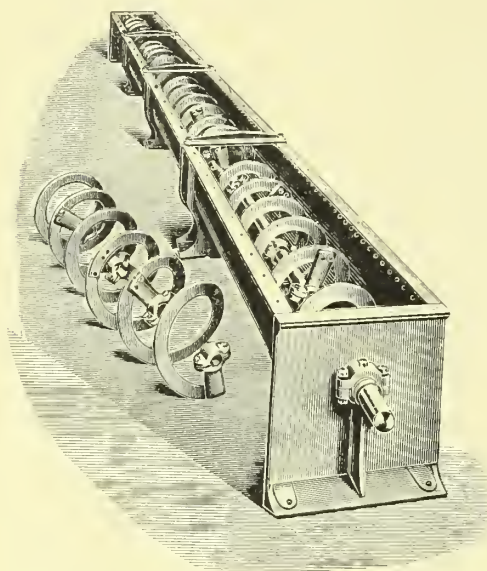


FIG. 62.—SPIRAL RIBBON CONVEYOR.

largely on the character of the material, and varies, in good practice, from 150 for small to 300 ft. per minute for large worms; approximately, the number of revolutions per minute $= \frac{300}{\sqrt{d}}$, where d is the diameter of the worm in inches. The approximate capacity of continuous worms in cubic feet per hour $= 18\frac{1}{2}(d - 2\frac{1}{4})^2$. In the case of paddle or ribbon worms this figure should be reduced by 20%.

Gritty materials and substances which cake together are not suitable for transport by means of worm conveyors. With suitable materials the power required to drive worm conveyors is given approximately by the formula—

$$\text{H.P.} = \frac{WL\mu}{33,000 A}$$

where W is the weight of the material conveyed per minute, L is the length of the trough in feet, μ is the coefficient of internal friction of the material, and A is a factor depending on the efficiency of the worm, and is usually about .4. The value of μ is given by the following table :—

COEFFICIENTS OF INTERNAL FRICTION.

Finely-ground coal (98% through 100-mesh sieve)	29
Anthracite (.1 to 2-in. cubes)	50
Wheat	53
Sand or crushed ore	67
Bituminous coal (.1 to 2-in. cubes)	70
Ashes or soft ore	84

A form of worm conveyor which is very con-

venient in some situations consists of a rotating tube provided with an internal spiral. Such conveyors take more power to drive and are somewhat limited in range of capacity. The best pitch for the spiral is about two-fifths of the diameter of the tube, and the peripheral speed is given by the formula for the ordinary worm conveyor ($\text{R.P.M.} = \frac{300}{\sqrt{d}}$).

(To be continued.)

ENGINEERING NOTES.

BY R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

Nomenclature of Alloys.

On November 25th the writer was present at a discussion on the above subject in the White Horse Hotel, Birmingham.

The discussion was opened by Dr. Rosenhain, of the National Physical Laboratory, and among the speakers who followed him were Mr. Bodecker, Dr. Bengough, Dr. Johnson and Mr. Rogers.

The meeting was one of the branch meetings of the Institute of Metals.

Anyone familiar with the brass, bronze and German silver trades has scarcely to be told that the nomenclature of their trade products is far more involved, misleading and obscure than most of the problems connected with their metallurgy—and that is saying a good deal. Leaving aside fancy names such as Tombac, Melloid and others, an instance of misleading nomenclature very much to the point was given by the head of one well-known local firm who said he sold to some Australian customers as a bronze an alloy usually known in the trade as a "gilding metal," *i.e.*, 88 copper and 12 zinc. "If he said to the customer 'this is a gilding brass' they would resent it and probably go somewhere else, if he sold them a genuine bronze, it would be quite unsuitable to their purpose; what was he to do?" This case is typical of a host of others, and has arisen because in the past the acute secretiveness of the Birmingham (and brass in general) manufacturer caused him to coin misleading names for any new combination which he found particularly suited to a new field in the hope that no competitor would readily discover its composition and charge into his preserve.

The spread of technical education has largely rendered unnecessary and abortive this kind of action, which was at all times an obnoxious practice; it is more so now in that it is more irritatingly than effectively misleading.

Shortly, Dr. Rosenhain's suggestions to combat this were—

(1) That all alloys consisting of copper and zinc in which other constituents were present only as impurities should be called brass—but when another constituent was intentionally present, as in "naval brass," it should be called "tin brass," the small additional constituent's name being used as a qualifying adjective.

(2) The tin-copper alloys where other matter was present only as an impurity should be called bronzes.

(3) That the somewhat lengthy misdescription German silver should be dropped in favour of some shorter word such as the German "Argentan," or completely named according to its constituents in the order of their gravi-

metric inferiority, *e.g.*, nickel, zinc, copper, in the case of an alloy where the gravimetrically smallest constituent was nickel, and the next smallest zinc. A good deal of discussion took place on the above lines, some suggesting the addition of qualifying numbers as 10 to 15 brass, meaning a brass containing 10% to 15% of zinc—now commonly called a gilding metal.

Dr. Rosenhain, the writer thinks wisely, demurred to this suggestion on the ground that it might lead to close specification, a thing which, except in the case of certain classes of work, is not in the interests either of consumer or manufacturer.

A much more interesting point was raised by Dr. Bengough as to how those alloys were to be designated whose properties were largely due to the presence during melting of some such constituent as phosphorus or manganese, which, having exactly fulfilled its deoxidising function, was present as a scarcely and sometimes entirely imperceptible trace in the finished product. As far as the writer is aware, this important point acquired no very satisfactory answers from any quarter.

By-product Coking.

A paper under this title was read by Mr. G. S. Cooper to the Junior Institution of Engineers about the middle of October last.

It brought forward nothing very new or remarkable, but at the same time it formed a useful commentary on work proposed or going forward in various parts of the Kingdom.

One of the first points touched on was the difficulty experienced in getting blast furnace owners to touch coke made in the by-product furnace, and until Lowthian Bell tackled the matter on a works scale, it seemed that the by-product oven was doomed to a very secondary importance. To-day this trouble is passed, but a form of analogous pig-headedness against coke in general still exists in the domestic mind. At first sight, this might seem a matter of no importance, but until coke and gas are very much more freely used in this manner, the smoke nuisance which is now so acute in most large towns and manufacturing centres will continue.

The author gave an average yield for regenerative ovens as 70% coke, 5% tar, 1.5% sulphate of ammonia, 1% of benzol, and about 5,500 cub. ft. of surplus gas. These figures do not apply to gasworks practice, but though more volatile coals are generally used for such a purpose, the percentages of by-products are not usually much greater in individual cases. This throws an interesting light on the proposal (mentioned in several papers about that time) of the Dundee Corporation to set up a by-product recovery plant as an adjunct to their gasworks. As some of the council then pointed out, this would be a step of very doubtful wisdom. The further treatment of tar and by-products, though fairly remunerative on a moderately large scale, can scarcely be very paying in connection with a single gas-works unless the latter be one of the largest. It would be stretching a point to say this of the Dundee installation.

Another point of interest mentioned by the author was the fair control, within limits, which could be exercised by the by-product coker on the physical properties of the coke produced. This control is obtained by feeding the coal to the oven in a normal condition or powdered, wetted and compressed, according as the original nature of the coal requires, if a not too friable coke desired.

The point is of considerable importance, as in several industries the use of soft or friable coke is disadvantageous, and in some of the metallurgical applications, such as brass melting, a hard coke, which will not tend to break down till almost entirely consumed, is absolutely essential.

Tar for Road Binding.

Mr. W. G. Fearnside read a paper towards the end of November, before the Surveyors' Institution, dealing chiefly with the solvent effects of water on the condition of both the beds and surfaces of roads.

As he pointed out, roads suffer comparatively less at the crust from this cause than in their foundations, for at the crust traffic abrasion will always be the determining factor, though it may be considerably helped by the action of water if the metalling be of a particularly soluble nature.

The great danger on important roads, however, where they traverse flat and wet country, lies in the solvent action of the water on the deeper structure of the road, for when this deeper structure is inadequately drained, depressions form from place to place which no amount of filling up of the surface of the road will completely do away with.

Probably, as water becomes less, and tar or other bituminous material becomes more frequently used as a binder, this state of affairs will, with more efficient drainage, tend to right itself, and his suggestion that the metalling and other portions of the road should be treated with quicklime or otherwise rendered free from moisture, and put down thoroughly dry before treating with whatever bituminous matter that may be used as a binder, deserves to be carefully considered.

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, *Chartered Patent Agent,*
Queen Anne's Chambers, Westminster, S.W.

17300/12. INTERNATIONAL SALT CO., LTD., A. W. BROWN, J. H. WEBSTER and A. G. SALAMON. **Salt.**

In the manufacture of common salt in granular form from the molten state, by stirring or moving it about while cooling, means for effecting such stirring and moving consist of rotary pans and a stationary pronged or like device.

18449/12. R. W. WALLACE and E. WASSMER. **Electrolytic Production of Metals.**

A process for preparing metallic magnesium consists in treating a mixture of chloride and sulphide of the metal in an electrolytic bath.

19006/12. H. KAST. **Catalysts.**

Metals and metal oxides in a minutely divided state are prepared by heating the metal salts of the nitro-phenols by themselves or in their mixtures with or without the admission of air to a degree till the metal or the metal oxide separates itself.

20536/12. E. W. KUHN. **Concentrating Liquids.**

In the condensation or concentration of milk and other liquids by freezing effected by means of refrigerating elements immersed in the milk or other liquid, the refrigerating elements have a suitable motion imparted thereto.

14152/12. **FARBENFABRIKEN VORMALS FRIEDRICH BAYER & Co., Elberfeld. Aminonaphthol Sulphonic Acids.**
17 June, 1912.

A process for producing new halogen derivatives of the 2·5-aminonaphthol-7-sulphonic acid and of the 2·8-aminonaphthol-6-sulphonic acid consists in treating the diacidyl derivatives of these acids containing an acidyl residue in both the amino and hydroxy group with chlorinating or brominating agents and in eliminating the acidyl groups from the products thus obtained. (2 claims.)

13501/13. **R. CALVET. Explosives.**

A primary explosive consists of a mixture of sulphocyanides of copper and potassium chlorate or perchlorate.

22623/12. **E. I. DU PONT DE NEMOURS POWDER CO. Celluloid.**

This process for the manufacture of celluloid comprises colliding an ester of cellulose, such as nitro-cellulose, or colliding nitro-starch with an aldol.

22988/12. **G. CIAPETTI. De-alcoholising Fermented Liquids.**

A process of de-alcoholising fermented liquids consists in first separating the volatile ethers and dissolved gases, then passing the liquid at a reduced pressure through a continuous still, wherein its complete passage occupies as short a time as possible, and subsequently mixing with the de-alcoholised liquid the first extracted volatile ethers.

23682/12. **J. L. PALMER. Rubber Extraction.**

Rubber is extracted from landolphia bark concentrate or the like by rolling the material between and along two frictional surfaces rotating relatively to one another at a high speed until the material is separated into masses of cohering material consisting in the main of coagulated rubber worms and more or less barren particles of bark or the like.

18060/13. **F. A. BYRNE. Rubber.**

Rubber latex or coagulated rubber is subjected to the vapours or gases obtained by the application of heat to phenols or to a mixture of the vapours or gases of a phenol or phenols with the vapour of pyroligneous acid or other coagulant.

18062/13. **F. A. BYRNE. Rubber.**

Rubber latex or coagulated rubber is subjected to sulphurous acid gas (which may be prepared by burning sulphur) delivered into or on the latex or rubber.

2096/13. **BADISCHE ANILIN AND SODA FABRIK. Hydrogen.**

Hydrogen is manufactured by alternately passing steam and a purified reducing gas over a ferruginous mass, the steam and the reducing gas being passed, before they enter the reaction furnace, through regenerators situated outside the said furnace, so that practically no transference of heat by conduction takes place from the regenerators to the furnace and the reducing gas which leaves the furnace being used for heating up the regenerators by burning it with oxygen.

3436/13. **NAAMLooZE VENNOOTSCHAP ALGEMEENE UITVIN-
DING EXPLOITATIE MAATSCHAPPIJ. Animal Charcoal.**

A particularly active animal charcoal is manufactured from fish by first boiling with water, sea-water or fresh-water fish which have been washed with cold water, then completely drying the mass and finally carbonising the powder thus obtained in the usual manner.

24623/12. **M. VON RECKLINGHAUSEN, A. HELBRONNER and V. HENRI. Sterilising Water.**

In apparatus for sterilising water by means of ultra-violet rays, the flow of water under the influence of the rays is arranged to be retarded by means of a baffling member composed of material translucent to ultra-violet rays and completely immersed in the water to be sterilised.

24854/12. **F. A. BYRNE. Rubber.**

Rubber latex or coagulated rubber is subjected to the vapours or gases obtained by the application of heat to an aldehyde or aldehydes, or to a mixture of the vapours or gases of an aldehyde or aldehydes with the vapour of pyroligneous acid or other coagulant of rubber latex.

25260/12. **BADISCHE ANILIN AND SODA FABRIK. Ammonia.**

Ammonia is absorbed from gas mixtures under a pressure exceeding ten atmospheres by introducing the absorbing liquid and treating the gas mixture with it in a tube or other suitable vessel in such a way that the gas and the absorbing liquid move in the same direction through the tube or vessel.

25832/12. **C. W. TURNER. Distilling Petroleum.**

The process of distilling and separating hydrocarbon oil into distillates of different gravities consists in forcing oil and water under pressure through heated coils, combining the resulting vapours and subjecting them under pressure to a decomposing temperature, and then admitting the products into vessels of larger diameter.

26770/12. **BADISCHE ANILIN AND SODA FABRIK. Hydrogen.**

Hydrogen is manufactured by causing carbon-monoxide and steam to react under pressure in the presence of a catalytic agent at a raised temperature.

27869/12. **W. G. PERKINS. Copper Smelting Furnaces.**

The invention comprises, in a copper smelting plant, the combination of a non-reversible, gas-fired, reverberatory furnace, a regenerator and a device between the furnace and the regenerator adapted to remove dust from the waste gases passing to the regenerator.

145/13. **J. SOVIGNET. Roasting Iron Ores.**

A process of roasting carbonate minerals of iron consists in roasting the mineral with a gradual increase in temperature in order to bring the mineral slowly to a temperature just sufficient for roasting and to bring it into intimate contact with a quantity of hot air just sufficient to oxidise it without allowing protoxide of iron to subsist.

Literary Intelligence.—Messrs. J. & A. Churchill are about to publish the following new books and editions: "A Manual for Masons." By J. A. Van Der Kloes, Professor in the Science of Materials of Construction, Technical High School, Delft. Revised by Alfred B. Searle. "Modern Steel Analysis." By J. A. Pickard, B.Sc., Honours London A.R.C.Sc., A.I.C., F.C.S. "Materia Medica, Pharmacy, Pharmacology and Therapeutics." By W. Hale White, M.D., F.R.C.P. "Elementary Practical Chemistry." Part I. By Frank Clowes, D.Sc.Lond., and J. Bernard Coleman, A.R.C.Sc. Sixth Edition. With 76 illustrations. "The Medical Directory," 1914. "Who's Who in Science," 1914. With over 9,000 biographies.

REVIEWS OF BOOKS.

"DIE KULTUR DER GEGENWART." Vol. III. "Chemie," edited by E. v. Meyer; **"Allgemeine Kristallographie und Mineralogie,"** edited by Fr. Rinne, assisted by C. Engler und L. Wohler, O. Wallach, R. Luther, W. Nernst, M. Le Blanc, A. Kossel, O. Kellner und H. Immerdorf and O. Witt. TEUBNER, Leipzig, 1913. Pages 663 + xiv, with Index and 53 Illustrations. Price M.18.

THIS extensive volume, which runs to some 650 pages, is intended to deal in a general manner with chemistry as it stands to-day, and also with crystallography and mineralogy. The first part of this work deals with chemistry, and is divided into eight sections, each of which is written by a noted chemist. Such well-known names as those of O. N. Witt, who writes on technical matters; W. Nernst, who deals with thermochemistry; E. von Meyer (the editor), L. Wohler, O. Wallach, and others are prominent. The section dealing with mineralogy and crystallography is also, from a general point of view, equally satisfactory, and there can be little doubt that, as this volume becomes known in this country, it will secure a number of readers. It is a worthy addition to any library.

"QUANTITATIVE ANALYSIS IN PRACTICE." By John Waddell. J. & A. CHURCHILL, London, 1913. Pages 162 + vi, with Appendices and Index. Chapters XIX. Price 4/6 net.

This work contains in a handy and condensed form particulars of methods adopted under practical conditions. It will certainly be found useful for this reason alone. The chapters dealing with the analysis of cements, limestone, coal, and iron ore seem to be particularly useful. The author claims that his endeavour has been to connect analytical processes with the general properties of the substances concerned. He has certainly produced a book which will be of value to the general analytical chemist, and those interested in the industries which are concerned with such raw materials.

"ORGANIC CHEMISTRY." Vol. II. By Julius B. Cohen. EDWARD ARNOLD, London, 1913. Pages 427 + vii, including Index. Chapters V. Price 16/- net.

This second volume has been written in view of the growing importance of the physical properties in their relation to structure and the general development of the physical side of organic chemistry. The chapters in the present volume deal with the valency of carbon, the nature of organic reactions, the dynamics of organic reactions, physical properties and structure, and colour and structure. The scheme adopted is an excellent one, and will be found of almost unique value to the student and those engaged in industrial work who desire to keep abreast of the recent developments in organic chemistry.

"WHO'S WHO IN SCIENCE. INTERNATIONAL, 1914." Edited by H. H. Stephenson. J. & A. CHURCHILL, London, 1913. Pages 662 + xii, including Classified Index and Frontispiece. Price 10/- net.

In the third annual issue of this important publication, particulars are given of no less than 9,000 scientists, of which the British element constitutes rather less than one quarter of the whole.

The book, as before, is divided into sections dealing with the world's universities, societies, biographies and an obituary for 1913. A supplementary list and index completes this valuable book of reference, which should naturally find a place on the desk of every scientist who needs to refer to the work of others in his own and other branches of investigation.

"THE PROGRESS OF SCIENTIFIC CHEMISTRY IN OUR OWN TIMES." By Sir William A. Tilden. Second Edition. LONGMANS, GREEN & Co., London, 1913. Pages 366 + x, with Index and Bibliography. Chapters XI. Price 7/6 net.

The success of this work has called for a second edition. The author's admirably clear style is nowhere better illustrated than in this volume, in which the student has placed before him the present position of chemistry as it has evolved out of the previous order of things. The chapters dealing with the development of synthetic chemistry and the origin of stereo-chemistry are particularly interesting. This volume can be recommended with great confidence to the general student.

"A TREATISE ON QUANTITATIVE INORGANIC ANALYSIS." Vol. I. By J. W. Mellor. CHARLES GRIFFIN & Co., LTD., London, 1913. Pages 778 + xxxi, with Appendix and Index. Divided into V. Parts and XLIV. Chapters, with 2 Coloured Plates and 206 Illustrations. Price 30/- net.

This important work will be welcomed by those interested in inorganic analysis, as it deals with the subject under consideration in a very exhaustive manner. Part I. concerns itself with a review of the methods adopted in analysis, and little need be said about this section, except that the chapters dealing with pulverisation, grinding, and sampling are of special value.

Part II. is entitled "Typical Silicate Analysis-Clays," and contains nineteen chapters. It opens with the determination of volatile matters and the opening up of silicates, and then deals with the determination of silica, iron, titanium, calcium, magnesium and the alkalis, etc. One of the features in this section and, indeed, the book in general, is the inclusion of a large number of references to original papers, which materially adds to its value.

Part III. deals with the analysis of glasses, glazes, colours and complex silicates. This section is also useful to the general analyst.

Parts IV. and V. are concerned with special methods, including those for the determination of zirconium, thorium and the rare earths, the determination of carbon, boron, oxide, etc. The ninety-four tables and illustrations also add to the usefulness of this text-book, which is of a very high order.

BOOKS, ETC., RECEIVED.

"The Microscopic Analysis of Metals," by Floris Osmond. Second Edition. Charles Griffin & Co., Ltd., London, 1913. Pages 313 + xi, with Appendices and Index. Divided into 3 Parts. 192 Illustrations. Price 8/6 net.

"Photo-Electricity. The Liberation of Electrons by Light," by H. Stanley Allen. Longmans, Green & Co., London, 1913. Pages 221 + vii, with Index. Chapters XIV., with 15 Illustrations. Price 7/6 net.

"Outlines of Theoretical Chemistry," by Frederick H. Getman. Chapman & Hall, Ltd., London, 1913. Pages 467 + ix, with Index. Chapters XIX., with 104 Illustrations. Price 15/- net.

"Quantitative Analysis by Electrolysis," by Alexander Classen. Translated by W. T. Hall from the Fifth German Edition. Chapman & Hall, Ltd., London, 1913. Pages 308 + vii, with Index. Divided into 4 Parts, with 51 Illustrations and 2 Plates. Price 10/6 net.

"Who's Who in Science, International, 1914." Edited by H. H. Stephenson. J. & A. Churchill, London, 1913. Pages 662 + xii, including Classified Index and Frontispiece. Price 10/- net.

"Rays of Positive Electricity and their Application to Chemical Analyses," by Sir J. J. Thomson. Longmans, Green & Co., London, 1913. Pages 132 + vi, with Index and 50 Illustrations. Price 5/- net.

"Physical Chemistry. Its Bearing on Biology and Medicine," by James C. Philip. Second Edition. Edward Arnold, London, 1913. Pages 326 + vi, with Index. Chapters XIV., with 24 Illustrations. Price 7/6 net.

A "New Era in Chemistry," by Harry C. Jones. Constable & Co., Ltd., London, 1913. Pages 326 + xiii, with Appendix and Index. Chapters XII. Price 8/6 net.

"Safety Electric Switches for Mines," by H. H. Clark. Technical Paper 49, Bureau of Mines, Washington, U.S.A., 1913. Pages 8.

"Heavy Oil as Fuel for Internal-Combustion Engines," by Irving C. Allen. Technical Paper 37, Bureau of Mines, Washington, U.S.A., 1913. Pages 36.

"The Prevention of Waste of Oil and Gas from Flowing Wells in California," by Ralph Arnold and V. R. Garfias. Technical Paper 42, Bureau of Mines, Washington, U.S.A., 1913. Pages 15, with 2 Plates and 4 Illustrations.

"Foundry-Cupola Gases and Temperatures," by A. W. Belden. Bulletin 54, Bureau of Mines, Washington, U.S.A., 1913. Pages 29, with 16 Illustrations and 3 Plates.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

Wood Wasted in Sulphite Process.

According to a bulletin issued by the Forestry Branch of Ottawa, over 145,000 cords of pulp wood, valued at \$800,000, are lost in Canada annually in connection with the manufacture of chemical wood pulp by the sulphite process. In making this calculation, it was stated that, of the 200,000 cords treated by this process in Canada last year, one half of every cord was dissolved by the liquor in which the wood was boiled, and discharged into the adjacent rivers as waste liquor.

The Forestry Branch further states: "Nor is this the only loss, for by this process 140 lbs. of sulphur are required to dissolve the waste materials out of each cord of wood. Some of the gases generated in the process are recovered, but most of the sulphur passes off in the waste liquor, and no method has yet been found to recover it for use a second time. Sulphur costs \$25 per ton, and the loss in this particular is equivalent to a money loss of \$500,000 on the total amount wasted."

It is stated that the department will devote considerable attention to the important problem of utilising this waste liquor, and that the matter will be taken up by the new Forest Products Laboratory being established by the Dominion Government at McGill University, Montreal. Some experiments have already been made by various pulp

companies in the use of the liquor for street watering. The Forestry Branch, however, hopes for much more profitable utilisation than this, for it says: "The waste liquor contains many materials, such as oxalic acid, tannin extracts, dye-stuffs, and alcohol constituents, which, if they could be easily recovered, would make the liquor of great commercial value; but in spite of the tremendous amount of work which has been done on the subject, especially in Europe, the problem still remains for the most part unsolved. As the liquor also contains carbo-hydrates, it should be possible to obtain turpentine, and eventually even rubber from it."

Growing Use of Ammonium Sulphate in China.

For many years Manchurian bean cake has been extensively employed as a fertiliser in the vicinity of Amoy, but since 1903 the use of sulphate of ammonia has become more common. To use the bean cake the farmer must pound the cakes to a dust, and this powder must be soaked in water for three days before it can be used. The sulphate of ammonia dissolves in water almost immediately, and thus can be used with greater facility. Of the two kinds of sulphate of ammonia, the pure white and the grey-reddish mixture having a strong odour, the latter is the kind used. Sulphate of ammonia is used in the Amoy district principally for fertilising rice and sugar-cane fields. It is said to have four times the strength of the bean cake, and to cost

but three times as much, which, taken together with the added facility of application, creates a growing market.

Imports of Dyes, etc., in Changsha.

The import of aniline dyes and of artificial indigo has nearly trebled itself in 1912, after steadily improving for several years. This is directly due to the enterprise of two European companies who, during the course of 1912, sent several commercial agents to travel in the interior of the province to push the sale of their goods. The increase in the import of Japanese matches is chiefly due to the suspension of work by the local factory owing to the disturbed political situation. A British firm has developed a good business in engine oil, having ousted, with a cheaper and superior article, a German firm which had previously held a practical monopoly of the trade in Changsha.

Wood Alcohol in Germany.

The American Consul-General at Berlin reports on the German wood alcohol industry as follows: There are no statistics available which would indicate the exact production of wood alcohol or its by-products in Germany, but a reliable estimate, made several years ago, places the annual output in Austria-Hungary and Germany on the basis of 100° purity at about 6,500,000 kilos. Separate figures for each of the two countries were not obtainable.

In 1912 Germany imported 9,398 metric tons of crude wood alcohol, having a total value of £290,788, compared with 8,759 tons worth £271,034 in 1911. Of these imports the United States supplied 4,319 tons in 1911 and 3,739 tons in 1912. Germany also purchased last year 912 tons of crude acetone from Austria-Hungary, the value of which was £36,890, the corresponding figure for 1911 being 767 tons and £31,035.

Exports from Germany of crude wood alcohol and acetone aggregated 263 tons in 1912 compared with 766 tons in 1911, and of refined wood alcohol, acetone, and formaldehyde 4,602 tons against 3,954 tons were shipped. About 41% of the former quantity was refined wood alcohol, 22% acetone, and 37% formaldehyde. The price of refined wood alcohol f.o.b. Berlin in usual wholesale quantities for August, 1913, was 166.50 marks per 100 kilos. Crude wood alcohol was quoted at 65 marks and refined acetone 145—160 marks, according to quality.

Sicilian Sulphur Production.

According to the report of the Consorzio, the total production of Sicilian sulphur for the year ending July 31st, 1913, was 366,457 tons, against 391,908 tons for the previous twelve months. Exports to the United States amounted to 7,125 tons. Sales for future delivery during the working year reached 526,767 tons. Local prices remained steady.

Boric Acid and Borax Ore in California.

A report from Washington states that deposits of colemanite, an ore of boric acid and borax, were discovered in California in 1898, and the district has yielded about 35,000 tons of crude ore, valued at about \$1,000,000. This colemanite, although classed among the few important deposits of this kind of ore in the country, has suffered the disadvantage of being a long distance from the main routes of transport. As in the case of many other Western industries, however, it is expected that the opening of the Panama Canal will greatly stimulate production. An examination of the borate deposits of California was

recently made by a Government expert, and while the investigation was not sufficiently detailed to permit an expression of opinion as to the magnitude of the undeveloped deposits, it is believed that they are very considerable.

The Value of Sugar.

In a comment on the multiple uses of sugar, *The Lancet* points out the fact that sugar is a cheap carbohydrate containing a rich proportion of carbon, and that it acts in some cases as an acid, forming definite and soluble compounds with the bases, rendering it a useful agent in certain industrial processes. It is, for example, the foundation of common boot-blackening. To some extent this has been replaced by wax and fluid polishes, but the old blackening made from sugar is regarded by many people as holding its own both as a polisher and preserver of the leather. Sugar is also employed in the manufacture of leather in order to remove the lime used as a scourer of the hides. Sugar enters also largely into the composition of copying inks, and printers' rollers are made up of a mixture of glue and glycerine or sugar. It is also used as a cheap substitute for glycerine or alcohol in the manufacture of transparent soaps. Sugar, again, forms nitro-compounds, and hence a series of explosives owe their potentialities to the association of sugar with nitric acid. These are but a few of the uses to which sugar in different forms may be applied, and no mention is made of the high value of the article as a nutritive.

Congress of Soap Makers in Russia.

The first congress of Russian soapmakers will take place at the time of the National Exposition in Kieff. The programme includes, among other things, the formation of a soap factory for instruction purposes. The Russian soap industry is hampered in its normal development by an insufficient number of specialists in the country, and to remedy this state of affairs it is proposed to establish a factory school. The congress will also discuss the high import duties which make the importation of the various oils and other ingredients for soap making so difficult, and which increase the price of soda by 100%.

New Patent Medicine Regulations in Cuba.

Advices have been received in Washington by the Foreign Tariff sections of the Bureau of Foreign and Domestic Commerce from Cuban authority, to the effect that the Department of Health at Cuba has recently promulgated new patent medicine regulations and comprehensive changes, governing the preparation and sale of pharmaceutical compounds. The rigid character of these regulations as contained in the decree of April 23rd, 1913, called forth a request from the National Pharmaceutical Association, that more time be given for the compliance with the new requirements. This resulted in the issuing of a supplementary decree, modifying certain clauses in the original decree. Non-observance of the requirements is punishable by fine and confiscation of the product. An abstract of the regulations relating to patent medicine is given in the *Oil, Paint and Drug Reporter*, of New York (October 20th, 1913).

American Government Inquiry into the Monopoly of the Fertiliser Industry.

The anti-trust campaign in the United States is likely to threaten the existence of the leading American fertiliser concerns. The latest evidence of the tendency to abolish

monopolies, is a proposition to inquire into the alleged control of commercial fertilisers in the country. A resolution to this purpose has been presented in the House by Representative Faison of North Carolina, which, if passed, will give the manufacturers in the Southern States a very uncomfortable time.

CONSULAR REPORTS.

Valparaiso.

A consular report on the trade of the district of Valparaiso states that trade conditions were fairly good throughout the year, and the general prosperity of the country was maintained. The year opened with nitrate prices at 7s. 4d. f.o.b., and closed at 8s. 1½d., the very full price of 8s. 9½d. having been reached in November. This is the highest quotation for nitrate f.o.b. recorded since 1906. The comparative statistics for the last three years are as follows:—

	1910.	1911.	1912.
	Quintals.	Quintals.	Quintals.
Total production ..	53,590,000	54,800,000	65,200,000
Exports ..	50,780,000	53,200,000	54,200,000
Consumption ..	51,290,000	52,180,000	54,990,000
Total visible supply on December 31st	35,400,000	36,800,000	35,200,000

The above are the official figures, but it will be noted that, in spite of a theoretical excess of the year's production over the consumption, the total stocks on December 31st, 1912, were reported lower by 1,600,000 quintals than a year before. This is due to over-declaration of production, loss of nitrate cargoes at sea and other shortages. The net available production of nitrate in 1912 was short of the world's consumption by 3%. Although trade, on the whole, has been well maintained, the completion of the new port works which have been commenced should see great improvement, but this event is still some years ahead.

Demand for Essential Oil, Essences, etc., in India.

In an official report on the manufacture of aerated waters in India special reference is made to the fact that essences, syrups, etc., are mostly supplied by England. It is stated that there is a big field in India for the sale of flavouring syrups, essences, essential oils, colourings, etc., in connection with the aerated water industry. In the native trade especially aerated water sells best when sweetened or otherwise flavoured, and coloured particularly in red or orange. The chief essences employed are lemon, ginger and kola, and there is also a considerable demand for tartaric acid, citric acid and saccharine. There is a special demand for beverages of a tonic character, met chiefly by the use of quinine essences, blended with aromatics.

Inquiry for Acetone Oil.

H.M. Consul-General at New York reports that a merchant at a town in New Jersey inquires for the names of United Kingdom manufacturers of acetone in a position to supply acetone oil, of which he requires from 3,000 to 5,000 gallons per month. The name and address of the inquirer to be obtained on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall Street, E.C.

Artificial Manure at Reval.

There was a slight falling-off in the imports of artificial manure in the year under review. There was no importation of ground bones which formerly used to be a main factor in the trade with British shippers. Another article of British supply—superphosphate—has this time been received from German, Dutch, and Swedish ports, thus reducing the percentage of the British share in this trade from 35.09% in 1911 to 10.9% in 1912. The shipments of artificial manure in 1912 consisted of the following descriptions and quantities:—From the United Kingdom: Thomas' phosphate, 2,925 tons. From Germany: nitrate of soda, 1,435 tons; kainite, 6,470; superphosphate, 3,264 tons; Thomas' phosphate, 1,931; total, 13,100 tons. From the Netherlands: superphosphate, 944 tons. From Sweden: superphosphate, 380 tons. From Norway: nitrate of soda, 764 tons. Small quantities of superphosphate and kainite were received from Danish ports.

SCHUTZE'S AUTOMATIC ACID ELEVATOR.

THE raising of large volumes of acid or other corrosive liquors is an operation occurring in very many chemical industries, which is very generally performed with the aid of compressed air—either by the old-fashioned "acid egg" which requires constant attendance, or by various forms of automatic apparatus.

One of the best known types of the latter is that designed and manufactured by Paul Schutze & Co., A.-G., of Oggersheim in the Palatinate, a sectional elevation of which we show in Fig. 1.

The liquid flows into the apparatus from a feed tank placed at a suitable height above the inlet A and fills the elevator body. During this filling period the weight of the double-ball float is suspended from the compressed air inlet valve, while at the same time the lever D keeps the outlet valve open, so that the air displaced by the liquid escapes at F.

When the liquid reaches the upper ball B₁ the float rises, and in so doing opens the compressed air inlet valve, while closing the outlet valve. The compressed air now forces the liquid out through the discharge valve G into the rising main. As soon as the level falls to the lower ball B, the float becomes sufficiently heavy to close the air inlet; the compressed air still contained in the vessel now works expansively

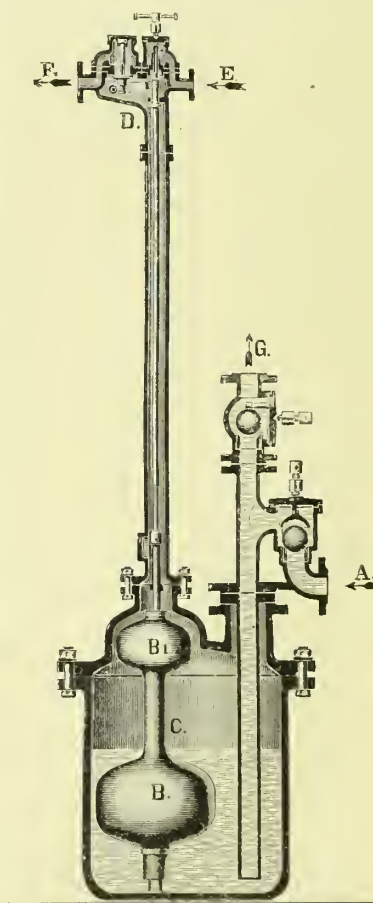


FIG. 1.

until the egg is nearly empty. Before, however, the air can escape into the rising main, the outlet valve is opened, the rest of the air blows off, and the whole cycle of operations is repeated.

The design of the float allows considerable variations in the specific gravity of the liquid, without disturbance of the automatic action, while the pressure of air may also vary within wide limits. The apparatus performs thirty to sixty operations per hour, according to the rapidity with which it is filled; as the volume discharged is always the same, the total quantity of liquid raised can be very easily controlled by a counting apparatus actuated by the valve gear D, which registers the number of discharges.

The automatic elevators are made in several sizes, from 50 to 250 l. capacity, and in a variety of materials—plain cast iron, cast iron with lead lining and lead-coated steel—so as to make them applicable to acids of different concentrations and temperatures. The valves A and G are of lead, or turned porcelain balls with lead seatings.

It will be noticed that no stuffing boxes are used throughout the apparatus, so that excessive friction or leaks are entirely avoided, and no attendance or repairs are necessary for years.

MARKET REPORTS.

LONDON.—The general position of the chemical trade is hardly more favourable than a month ago, although there are one or two features which seem to justify a slightly more optimistic feeling than that which recently prevailed in the market. A cause for general satisfaction consists in the better returns relating to the foreign trade in chemicals during the last month (November), as they disclosed a considerable increase of the shipments of the most important articles coming under the heading of chemicals, drugs, dyes, and colours. The exports of chemical manures amounted to 60,189 tons, compared with 53,911 tons in the same month of last year, and 55,372 tons in 1911. The value of the shipments rose at the same time from £5,021,319 in 1911 to £5,275,897 in 1913. Coal tar products, not dyes, show a similar increase, while the exports of dye stuffs increased in quantity, though the value experienced a slight set-back. Notwithstanding these favourable returns, there are many complaints among manufacturers and exporters of the difficulty of arranging new business with foreign buyers, and it is feared that the future will witness a general decrease of exports.

The condition in the home section is barely promising. The depression in the metal trades, caused mostly by dullness in the engineering industry, shows no signs of lifting as yet; while the textile manufacturers in Yorkshire and Lancashire are bitterly complaining of slack trade and lack of work.

Tar products have hardly improved since our last report. The tendency of the pitch market has gradually become weaker, and the efforts of the buyers to create a more advantageous position for covering their needs have proved successful. This does not prevent some makers from expecting better prices early in the new year, but at present the quotation is hardly more than 40s. The export figures for benzols disclose a continued progress, and the shipments for the whole year will form a record. The home demand, too, remains quite satisfactory owing to the extended consumption of the article for motor fuel purposes. Fifty per cent. prompt benzol is quoted at 11½d. to 1s., and 90% prompt at 1s. 1d. to 1s. 1½d. per gallon. Carbolic acid

showed some faint signs of an improvement, although the consumers refuse to pay more than 1s. 1d. per gallon, including casks and 3½d. to 3¾d. for crystals. Lower prices seem unlikely, and a slight increase of the demand would probably force prices upward very quickly. Naphthalene enjoys very steady demand at firm prices.

MANCHESTER.—The market for heavy chemicals is dull. Some recent contracts were made in terms which favoured buyers, indicating that the manufacturers anticipate a quieter time than hitherto. Powdered arsenic is fairly steady at £13 5s. The demand for citric acid is good, but the scarcity of the material and the high prices exercise an unfavourable influence on the business. The market for sulphate of copper fluctuated in accordance with the metal. The latest quotation was £22 for prompt and 2s. 6d. to 5s. more for spring delivery, makers evidently expecting a revival of the demand in the spring months. Lead salts maintain their position, and nitrate of lead is inquired for. Sulphate of ammonia is very quiet, and the expectation of a revival in the American demand has not yet materialised. The shipments during the last month showed a substantial increase in comparison to those of last year, but new business is difficult to arrange, although makers are prepared to sell prompt at £12 17s. 6d. per ton. Forward buying leaves much to be desired in spite of a small premium on spring delivery.

LIVERPOOL.—After a very quiet period the business has lately brightened up in the chemical trade, although it can hardly be called particularly active. The lower prices for sulphate of copper have stimulated the inquiry and some fairly large transactions have taken place which encouraged sellers to show more reluctance and increase their prices. This resulted, however, in a similar movement on the part of the consumers who have once more retired from the scene. The quotation for sulphate of copper is, therefore, irregular at £22 7s. 6d. to £22 10s. Very little interest is evinced in sulphate of ammonia. The producers have even trouble in getting buyers to take delivery on existing contracts, and new business is equally difficult to obtain. The tendency favours buyers, who seem quite indifferent to this fact. Sulphate of ammonia for prompt delivery is offered at £13 10s. to £13 15s. f.o.b. Liverpool. The demand for bleaching powder remains steady and some fair business has taken place in early delivery. Nitrate of soda tends slightly upwards, although the inquiry is by no means active; holders ask £10 15s. to £11. Cream of tartar remains dull at 88s. for 93% and 90s. for 98% quality. Citric acid is quiet but steady at 2s. 1d.

TRADE ITEMS.

E. Merk issues a list of chemicals for photography, perfumery, electro-chemistry and metallurgy, and those used for the laboratory. The latter include alkaloids, glucosides, ferments, etc.

Messrs. Lacy-Hulbert & Co., Ltd., of 91, Victoria Street, S.W., issue a list of their Boreas rotary pumps delivering from 10 galls. to 2,000 galls. per hour. Also particulars of air compressors and vacuum pumps.

With reference to the notice in the *Board of Trade Journal* of November 6th, relative to the proposed opening of a factory near Sandefjord to work a new Austrian process for the chemical treatment of whale oil, H.M. Consul at Christiania (Mr. E. F. Gray) reports that the prospectus of the new company was published in the *Norwegian Official*

Gazette of November 8th. The company will be styled the "Vera Fedtraffineri Aktieselskab," and will have a maximum capital of 2,500,000 kr. (minimum 2,000,000 kr.), divided into shares of 1,000 kr., of which the promoters have already subscribed 543,000 kr. The registered offices will be at Sandefjord. The company will have the sole right of working in Norway the Hydrier method of hardening and treating oils and fats, and is arranging for an annual output of from 12,000 to 15,000 tons of the finished product.

The Engineering Improvements Co., Ltd., of 39, St. James' Street, S.W., are supplying a self-locking nut known as the "Perflox." A spring is fitted spirally in the thread whose inner surface constitutes the thread of the nut. Under working conditions the nut exhibits a tendency to tighten, but a slight pressure applied to the projecting end of the spring releases the binding action.

Highways Construction, Ltd., of Finsbury Court, E.C., issue an account of their asphalt-macadam road construction. The pamphlet may be obtained by reference to this firm by those interested in such matters.

FINANCIAL NOTES.

The Cassel Cyanide Co., Ltd., announce a profit of £69,300 for the last trading year, which, with the balance brought forward, makes £82,786 in all. A further dividend of 1s. making 2s. in all for the year is to be paid with a bonus of 1s. 6d. £11,099 is carried forward.

The gross profits of the Stassfurter Chemische Fabrik, Vorster & Grüneberg A.-G., amounted to 568,944 marks, compared with 504,574 marks last year; and the net profits, after writing off 142,687 marks, against 143,777 marks, were 426,257 marks (360,797 marks). The directors propose to pay a dividend of 9% on the old shares and 4½% on the new ones. The amount to be carried forward is 21,026 (24,913) marks.

Gebrüder Heyl & Co. A.-G., Charlottenburg, near Berlin, have a trading profit of 608,000 marks (623,800 marks last year), and an income of 24,300 marks (31,000 marks) from other sources, so that, after applying 230,400 marks (210,300 marks) to general expenses account, 50,100 marks (44,900 marks) to the payment of interest, and writing 128,500 marks (115,900) off the plant account, there remains a profit of 219,000 marks (287,500) from which it is intended to pay a dividend of 7% (9%) on 2,500,000 marks capital.

The gross profits of the A.-G. Vereinigte Chemische Fabriken (S. T. Morosow, Krell, Ottmann), Berlin, amount to 197,517 marks (138,025), and the net profits to 131,752 marks (76,618), allowing a dividend of 6% (5%) to be paid.

Alby United Carbide Co., Ltd.—The issue of 175,000 Ordinary £1 shares at a premium of 10s. per share has been largely over-applied for by the company's own shareholders.

The British Coalite Co. have apparently to show a net loss of £11,600, which is roughly that recorded for the previous year. The total debit balance of £150,000 is to be wiped off under the reconstruction scheme.

At the recent meeting of Mineral Separations, Ltd., the chairman gave interesting particulars concerning the results obtained with their process. The year showed a net profit of £5,000 after deducting working costs and depreciation. It was estimated that during 1913 nearly 3,000,000 tons of zinc, lead, and copper ores would be treated. This should

increase to 4,000,000 for 1914, and then possibly increase to 6,000,000 tons. The increase would be chiefly on copper ores. Such important groups as the Amalgamated Copper Co., D. Guggenheim, Phelps, Dodge & Co., and Senator Clark were among their licensees. The new differential processes were promising still greater improvements in the future. Both the Lyster and the Hebbard and Harvey processes were already working on a commercial scale by the Zinc Corporation, Ltd., and the Sulphide Corporation respectively. Both these processes belonged to Mineral Separations, Ltd., or their Australian company. They confidently expected a favourable issue to their American litigation. The appeal in the Hyde case would be heard during February next year, when their legal advisers had no doubt that the judgment of the lower court, which was given in their favour, would be upheld.

SHARE LIST.

Name of Company.	December 24th.	November 24th.
Alby United Carbide	1 ⁰ / ₁₆	1 ¹¹ / ₁₆ xd
Ditto. Pref.	1	1 ¹ / ₁₆
Associated Portland Cement. (10)	6 ¹ / ₁₆	6 ¹ / ₁₆
Ditto. Pref. (10)	8 ¹ / ₁₆	8 ¹ / ₁₆
Babcock-Wilcox. Ord. ..	2 ¹ / ₁₆	2 ¹ / ₁₆
Ditto. Pref.	1 ⁵ / ₁₆	1 ⁵ / ₁₆
Bell's United Asbestos	1 ³ / ₁₆	1 ³ / ₁₆
Bleachers' Association. Ord. ..	1 ¹ / ₁₆	1 ¹ / ₁₆ xd
Ditto. Pref.	1 ¹ / ₁₆	1 ¹ / ₁₆
Borax Consolidated. Pfd. (5) ..	5 ³ / ₁₆	5 ³ / ₁₆
Ditto. Defd.	1 ¹ / ₁₆	1 ¹ / ₁₆
Ditto. Pref. (10)	11 ¹ / ₁₆	11 ¹ / ₁₆
Bradford Dyers	1	1 ¹ / ₁₆
Ditto. Pref.	1	1 ¹ / ₁₆
British Oil and Cake. Ord. ..	4 ¹ / ₁₆	4 ¹ / ₁₆
Brunner Mond. Ord.	14 ¹ / ₁₆	14 ¹ / ₁₆
Ditto. 7% Pref. (10) ..	2 ¹ / ₁₆	2 ¹ / ₁₆
Bryant and May. Pref.	1 ⁵ / ₁₆	1 ⁵ / ₁₆
Calico Printers	1 ⁵ / ₁₆	1 ⁵ / ₁₆
Ditto. Pref.	1 ⁵ / ₁₆	1 ⁵ / ₁₆
Castner Kellner	3 ³ / ₁₆	3 ³ / ₁₆
Commercial Salt. (2/-)	8/-	8/-
Crossley & Sons. (2)	1 ¹ / ₁₆	1 ¹ / ₁₆
Ditto. 5% Pref.	4 ¹ / ₁₆	4 ¹ / ₁₆
Eastman Kodak. (\$100) ..	47 ⁰ / ₁₆	52 ⁰ / ₁₆
Eley Brothers	1 ¹ / ₁₆	1 ¹ / ₁₆
Fraser and Chalmers. (4/3) ..	3	3
Gas Light and Coke. (S.) ..	102	104
Ditto. 4% Pref. (S)	93	98
Greenwich Lino. (1/2)	1 ¹ / ₁₆	1 ¹ / ₁₆
Harrison and Crossfield. Pref. ..	1 ¹ / ₁₆	1 ¹ / ₁₆
Imperial Continental. (S) ..	160	165xd
Ditto. 3½% Debenture (S) ..	83 ¹ / ₁₆	85 ¹ / ₁₆
India Rubber Co. (10)	11 ¹ / ₁₆	12 ¹ / ₁₆
International Salt	5/-	6/-
Ditto. Pref. (5/6 pd.) ..	1 ¹ / ₁₆	2 ¹ / ₁₆
Lever Brothers. 1st Pref. (10) ..	11	11 ¹ / ₁₆
Lister & Co. Ord.	1 ¹ / ₁₆	1 ¹ / ₁₆
Mappin & Webb. Ord.	1 ¹ / ₁₆	1 ¹ / ₁₆
Neuch'tel' Asphalt. (10/-) ..	9 ¹ / ₁₆	9 ¹ / ₁₆
Nobel Dynamite. (10)	16 ¹ / ₁₆	17 ¹ / ₁₆
Ditto. Bearer (10)	17	17 ¹ / ₁₆
Ditto. 5% Pref. (10)	10	11
Pears, A. and F. Ord.	1 ² / ₁₆	1 ² / ₁₆
Ditto. 6% Pref. (10)	12 ¹ / ₁₆	12 ¹ / ₁₆
Price's Candle. (16)	34 ¹ / ₁₆	36 ¹ / ₁₆
Rosario (5)	8 ¹ / ₁₆	8 ¹ / ₁₆
Salt Union. (4)	1 ¹ / ₁₆	1 ¹ / ₁₆
South Metropolitan 4% Standard (S)	108	110
Ditto. 3% Debenture (S) ..	72	74
United Alkali. (10)	1	1 ¹ / ₁₆
Ditto. Pref. (10)	7 ¹ / ₁₆	8
Val de Travers	1 ¹ / ₁₆	1 ¹ / ₁₆



THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY W. P. DREAPER, F.I.C.

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

VOL. III. No. 2.

FEBRUARY, 1914.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
" " Abroad 8s. " "

College Training and the Works.

A letter published in this issue on the subject is one with which we are not necessarily in sympathy, nor at one with the argument adopted. The writer complains that the student on entering the works is not fully prepared for the conditions he meets there; that he learns more in the first six months in the works than he did during the whole of his college course.

He does not seem to realise that this statement might be equally used by those who consider the college training to be perfect. One might read into these words an argument in favour of the very training it is sought to decry.

A practical course of training is necessarily a compromise from an educational point of view; and the chemical department can hardly be called upon to turn out students who can immediately adapt themselves to the atmosphere of a works and find themselves at home in industrial investigation. The call to the college is surely to introduce a new factor into industrial life—to establish the scientific method.

If the argument adopted by the writer of this letter is correct, why should not the college course be skipped, and the student enter the works direct from school? The reply seems to us to be a simple one. As a matter of fact, it is increasingly difficult to find men who have devoted their attention to industrial investigation who will not insist that the great need is for a more general rather than a specialised knowledge on the part of the student; and that this may possibly be best attained at colleges, such as those at Cambridge, where the training is before all things a general one.

That there is a decided swing of the pendulum in this direction is seen in the effort of those responsible for many of the so-called technical colleges to point out that for the first two or three years their course is really one in general chemistry, and that only after this period is it in any sense technical.

If a man is to call himself a chemist, it goes without saying (or at least it would in any other profession) that he must have a fairly complete knowledge of his subject. When urging at the

recent conference held by the Institute of Chemistry that the Institute should not take any step which would lower the standard of qualification adopted at present, Mr. David Howard, speaking as a chemical manufacturer, plainly said that the call was for a supply of trained men who could use their brains—that the supply of bottle washers already exceeded the demand.

The fact remains that no reformer has ever been able to suggest a course of study which would allow a student to pass to the works as a fully fledged investigator. Such super-students will never be turned out by any college.

At the same time, it is evident, when one listens to some of the criticisms made by competent men on the practical knowledge possessed by the student as he leaves college, that certain changes may still be necessary. Either this, or that many of those who enter the chemical department as students should never have been allowed to do so; that they would have been better employed in some other direction, where hard thinking was a less necessary accomplishment.

Anyone who has perused the series of articles which have appeared in this journal on the college laboratories and their organisation as they exist to-day in this country cannot fail to realise that a positive revolution has taken place in the last twenty years in the matter of procedure. One may even go further, and say that the system which is being built up in this country bids fair to hold its own.

Research is more of an intimate mixture than a specific compound. It is a mosaic, in which clear thinking, hard work and opportunity are clearly distinguished.

As we have pointed out elsewhere, some further steps may have to be taken to secure to the student a better idea of the principles which underlie research. We hold that these can be taught in class, and that there is nothing mystic about them except so far as they may be empirical.

It is also held that if early specialisation in the colleges is bad, it is still clear water to the muddy stream of undue specialisation in the public schools. One of these days this will go the way of other fads, and probably when this occurs no one will be

sufficiently interested in it to trouble much about its exit.

Henri Bedou has recently argued that a nation is musical because it has passed through tribulation ; that its sorrows and anxieties are expressed in its airs and compositions ; that a nation sings to keep up its courage in affliction.

It may be that the manufacturers of this country have paid little attention to the call of science, because of the easy time they too have had in the past. At any rate, modern "affliction" in the shape of competition is fast altering this condition, and education and an ever-growing sense of justice toward those who devote their life to the furtherance of scientific knowledge is doing the rest.

In our next issue we publish an article from a well known industrial chemist who has had special experience in English and Continental manufacturing conditions in which a somewhat different attitude is adopted. This will, we hope, be followed by others on the same subject, which is one of considerable interest to the chemist.

Chemistry and Medicine.

From the recently published account of certain investigations conducted at the Middlesex Hospital, there is an indication that once more the chemist has come to the rescue, and provided a new weapon for combating disease. It is stated that during a recent period no less than 50% of a number of cancer cases have been discharged from the hospital. These cases were known as inoperable, and their ordinary mortality is 100%.

Some time ago the results obtained with certain organo-metallic compounds in the treatment of this disease were briefly noticed. If these have since been extended to human beings, their relative results obtained will be examined with great interest when they are published.

It is a feature of scientific investigation that once a new door has been opened, it is seldom shut without some advance in knowledge or benefit accruing. It is hardly possible to think that this condition will not also apply to these experiments, or that we can ever return to the old conditions. The prize to be won is probably the most important in medical science since Lister followed up the work of Pasteur, and obtained results which recast surgical practice over the civilised world.

The death rate in this country alone from this disease accounts for some 35,000 cases annually ; and it is difficult to have patience with the conditions which have led our investigators to lament the absence of a sufficient supply of radium for their experiments. In spite of all such difficulties, it is pleasing to record such favourable results, which, in any case, count as a triumph for the English investigator, and may possibly lead to the opening out of a new era in the treatment of disease.

It may be that Cornwall will come to the rescue with a more adequate supply of the raw material, and in this respect Government aid may have to supplement that of private individuals who are naturally governed in their operations by considera-

tions of personal gain rather than the larger issue of public benefit. The American Government has announced its policy in this direction. It will claim 25% of the radium ore raised, which will be worked up for the use of the Public Health Service.

Recent reports indicate that the chemist has not said his last word concerning the simplification of the methods utilised in the extraction process, and that one if not more processes have been devised which will materially cheapen the cost of production and the available supply of radium. The reported improvements take the form of a great decrease in the time required for the necessary purification of the radium salts.

NOTES OF MEETINGS.

Chemical Society.

February 5th and 19th.

Society of Chemical Industry.

LONDON SECTION.—Monday, February 2nd. (1) Mr. W. R. Schoeller. "Oxygen and Metallic Antimony in Crude Antimony." (2) Mr. T. K. Rose. "Estimation of Zinc in Coinage Bronzes by Volatilisation." (3) Mr. Puran Singh. "Nickel Tannates."

Society of Public Analysts.

February 4th. General Meeting. By G. D. Lander and J. J. Geake, "Iodimetry of Arsenic, Copper and Iron." A. E. Parkes, and F. Major, "Composition and Analysis of Compound Liquorice Powder." M. C. Lamb, "Composition of the Saline Matter adhering to certain wet salted skins."

Royal Institution.

February 13th, at 9 p.m. Professor J. Norman Collie, "Production of Neon and Helium by Electric Discharge."

February 14th and 21st, at 3 p.m. Dr. J. A. Harker, "The Electric Emissivity of Matter."

February 27th, at 9 p.m. Professor W. A. Bone, "Surface Combustion."

February 28th, at 3 p.m. Professor Sir J. J. Thomson, "Recent Discoveries in Physical Science."

Biochemical Society.

February 11th, at Chemical Department, Guy's Hospital Medical School, at 5.30.

Royal Photographic Society.

Technical Meetings: February, 3rd, 10th, 17th and 24th. Annual General Meeting, February 10th.

Institution of Civil Engineers.

February 3rd, 10th, 17th and 24th.

Institution of Mechanical Engineers.

February 20th. Annual General Meeting.

The Physical Society.

February 13th, at 8 p.m.

NEW X-RAY SPECTRUM ANALYSIS OF CRYSTAL STRUCTURE.

By A. E. H. TUTTON, D.Sc., M.A., F.R.S.

IN an article contributed to this journal just a year ago¹ attention was called to the rapid and almost startling manner in which chemical crystallography was developing. The revelation by means of X-rays of the inner structure of the crystal, the unfolding of the hidden mystery of the arrangement of the chemical atoms, had recently been proclaimed by Dr. (now Professor) Laue and Drs. Friedrich and Knipping, in Munich, and the first result had been to confirm by direct experiment what had long been surmised, that the basis of the structure of a crystal, its skeletal framework, is of the nature of a space-lattice or three-dimensioned grating. The evidence was incontrovertible, for it was indelibly and automatically recorded photographically. The narrow beam of X-rays received on the crystal was diffracted by the different planes of atoms inside the crystal (corresponding to the arrangement of those atoms as the points of a space-lattice) in such a manner that the issuing rays impinged on a photographic plate, where they recorded themselves after development of the plate as a pattern of dark spots showing the symmetry of the crystal system.

During the past year this new field of investigation has been explored with much success in this country by Mr. W. L. Bragg, and by his father Professor Bragg, whose valuable work on the nature of X-rays is well known, and who has utilised the new method in order further to elucidate that problem. So far from first hopes having proved too optimistic, they have been more than fulfilled, and it is now clear that an instrument of research into the inner structure of crystals of the utmost value is placed in our hands. No longer need we speculate, without hope of finality, as to the character of that wonderful structure, but instead we can test our theories by the only trustworthy method, which the writer has always inculcated, that of direct experiment. It is probable, indeed, that the time has now arrived when the theories of von Fedorow, Schönflies, and Sollas, the valency theory of Pope and Barlow, and the still more recent development by Barker of the co-ordination theory of Werner as applied to crystals, may be put to decisive proof. It cannot fail, therefore, to be of supreme interest to chemists to have a brief account of the present position placed before them.

The essence of Laue's photographic process is that a thin section of the crystal is placed in the path of a narrow pencil of X-rays of the general character emitted from an ordinary Röntgen-ray bulb, that is, of a "white" X-radiation comparable to white

light rays as distinguished from monochromatic light; the radiation is diffracted from the various types of internal planes of atoms (nets), which build up the crystal in space-lattice fashion, and records itself by a developable effect on a photographic plate placed behind the crystal, such effect taking the form of elliptical spots of varying intensity arranged in a pattern which possesses the full (holohedral) symmetry of the system to which the crystal belongs. For the existing or possible faces of crystals are parallel to planes of atoms (regarded as points) of the space-lattice, and the more important and fundamental the face the more densely is its plane packed with atomic points. Now these planes contain rows of atomic points more or less closely packed, and each of these point-rows will have a set of successive planes parallel to it, and it is these successive planes that are concerned in affording the diffraction spectra of X-radiation.

Professor Barkla appears to have been the first to observe that under certain conditions the spots in the photographs were striated, and the writer had the pleasure, by Professor Barkla's kindness, of exhibiting the first two such photographs taken, in

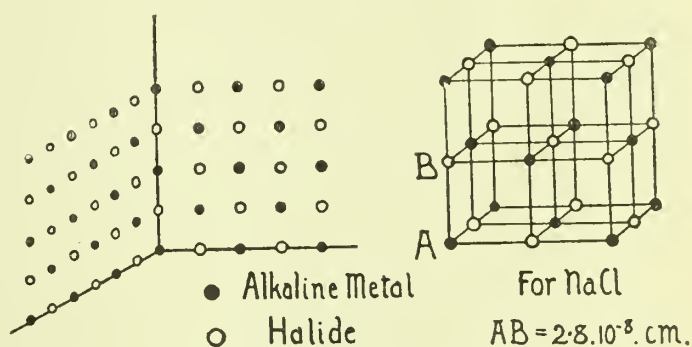


FIG. 1.—STRUCTURE OF THE HALIDES OF THE ALKALI METALS.

a lecture at the Royal Institution on March 14th last, as well as the original photographs sent by Drs. Laue and Friedrich for the occasion. Professor Bragg has since further elucidated the fact that interference occurs between the trains of X-rays diffracted from the successive parallel planes of atoms of the space-lattice just referred to, behind one another, within the crystal substance, and he has observed as many as five orders of diffraction spectra from any one such set of parallel planes. For these successive equally spaced parallel planes of atoms act like an echelon grating for X-rays, just as in a ruled grating or echelon-spectroscope we have produced the successive orders of ordinary light spectra. Further, from the character of the spectra of the different orders, that is, by observation of differences in intensity among them, or the absence

of any of the spectra, it is actually possible to measure the spacing of the planes, and hence the distances of the atoms apart, regarding them as points.

Conversely, the crystal space-grating acts as a spectroscop for X-radiation, and Professor Bragg has used it for the further development of the character of X-rays. He has discovered that by using certain metals for the material of the anticathode of the Röntgen-ray bulb, X-rays of specific wave-lengths only are emitted, just as glowing vapours of metals afford particular monochromatic radiations of ordinary light. Palladium has proved especially useful in this respect, and as it affords a radiation of practically a single wave-length, quantitative measurement of the distances between the atomic planes has been possible. Indeed, it is by no means necessary to employ either the photographic method of record, or to utilise the visual method of Terada (use of the ordinary fluorescent screen), but instead the reflected rays may be received in an ionisation chamber, which is preferably filled with sulphur dioxide gas in order that the ionisation currents may be as strong as possible, and their measurement by the ordinary laboratory methods rendered as delicate as possible. The ionisation chamber simply replaces the telescope of the spectroscop, the prism or diffraction-grating being replaced by the crystal, either as a section-plate or the whole crystal; the latter is mounted on a goniometer provided with the usual means of delicate adjustment and which is used as the spectroscop. The collimator is provided with a slit cut in a block of lead, and rendered adjustable for width. The whole apparatus is enclosed in a leaden box, or by leaden screens, pierced by a single aperture, which permits only the one desired pencil of X-rays from the bulb to enter the slit of the gonio-spectrometer. The various crystal faces or directions of possible faces can be adjusted in turn to receive the X-rays at more or less of a glancing incidence or series of angles of incidence.

Not only can the spacing of the successive parallel planes be measured by this apparatus, but the information can also be elicited as to whether or not successive planes are of identical, alternate, or periodically regularly recurring character. For in all cases other than those of very simple chemical compounds the successive planes form groups of differing character, which recur periodically in the same or some other definite (possibly mirror-image) order. That is to say, the successive planes of atoms encountered in passing along the direction perpendicular to the crystal face under examination are not, in general, identical in all respects; but they can always be divided into groups, each of which contains a sample of every kind of plane arranged in the same or some other regular order.

Now the condition for reflection of a "monochromatic" X-radiation from a series of parallel equally spaced planes is that—

$$n\lambda = 2d \sin \theta,$$

where λ is the wave-length of the X-ray, θ the angle

of reflection, d the distance between the successive planes, and n the order of spectrum. Thus, if we replace n by 1, 2, 3, 4, or 5, we get a series of angles $\theta_1, \theta_2, \theta_3, \theta_4, \theta_5$, which are the angles at which the various orders of spectra are reflected. Using palladium as the anticathode, λ has only two values, and the ray corresponding to one of these is so much more powerful than the other that the latter may be neglected and the radiation considered as "monochromatic." Its wave-length is 0.576×10^{-8} cms. At all angles of incidence of the X-rays on the crystal there is more or less general reflection, but at the angles θ_1, θ_2 , etc., there occurs a special superimposed reflection of relatively enormous (often twenty-fold) strength, which renders itself unmistakable by its powerful ionisation effect, and the location of which is easily found to within a few minutes of arc. If a curve be constructed, plotting angles of incidence or reflection against ionisation effect, the form of the curve is one rising rapidly to a steep maximum and suddenly falling again.

Among the simple compounds investigated by Mr. W. L. Bragg, the metallic halides, sodium chloride and potassium chloride, bromide, and iodide have proved remarkably instructive. The results by both the photographic and ionisation methods agree in indicating that the members of this group of salts are all characterised by the same type of structure, that shown in Fig. 1, their atoms being arranged as a simple cubic space-lattice No. 1,

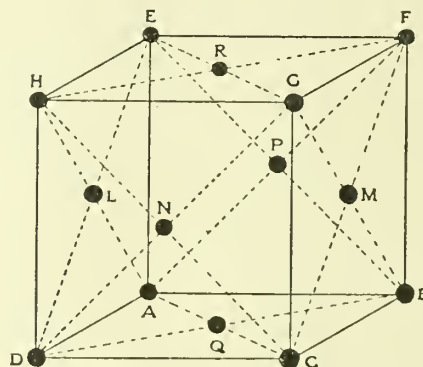


FIG. 2.—FACE-CENTRED CUBIC SPACE-LATTICE.

assuming that we disregard the nature of the atoms, that is, whether they be of metal or halogen.

Rows of atoms parallel to the cubic axes, however, consist of metal and halogen alternately, so that if either of the two kinds of atoms be considered alone the space-lattice is the face-centred cubic one No. 3, as shown for the metallic atoms in Fig. 2.

Now there has been revealed from these experiments a new and interesting law, that the diffracting power of an atom for X-radiation is directly proportional to its atomic weight. Hence, if the two chemical elements present are of nearly the same atomic weight, as in the case of potassium chloride ($K = 39.1$ and $Cl = 35.5$), the diffraction photographic spot-pattern corresponds to the symmetry of the whole arrangement, regardless of the kind of

atom; that is, in the case of potassium chloride it corresponds to the simple cubic space-lattice No. 1. This pattern for potassium chloride, redrawn stereographically (by which the pairs of construction ellipses become circles), is shown in Fig. 3.

If, however, the difference of atomic weight be

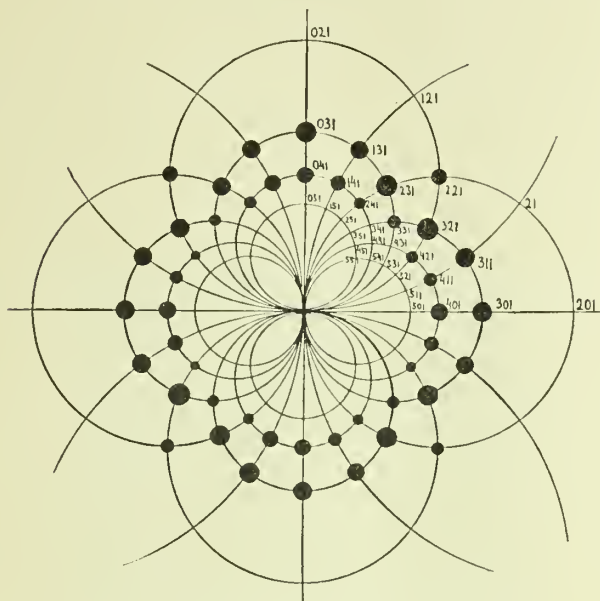


FIG. 3.—SPOT-PATTERN OF POTASSIUM CHLORIDE.

considerable, as with potassium bromide and iodide ($\text{Br} = 80$ and $\text{I} = 127$), a spot-pattern is obtained corresponding to the much heavier atoms alone (here those of bromine or iodine), and in the two salts just referred to it corresponds to the face-centred space-lattice No. 3, as shown in Fig. 4 for potassium bromide.

Sodium chloride forms an interesting intermediate case, for we have two elements, sodium and chlorine, of atomic weights respectively 23 and 35.5, and a pattern of intermediate type is obtained, as shown in Fig. 5.

On proceeding to quantitative examination of the reflections by means of the ionisation method, some weighty evidence of the nature of the successive planes, as to whether they are of the same or different kinds of atoms, has been obtained, from the presence, absence, or relative intensities of the spectra of the five orders. In the metallic halide group just referred to successive planes parallel to the cube faces $\{100\}$ are of identical character, both metallic and halogen atoms being present in equal proportions. If the cube edge be taken as $2a$, then the cube planes are separated at the distance a . The rhombic dodecahedral planes $\{110\}$ are also similar, containing both kinds of atoms, and they are separated at the distance $a/2$. The octahedral planes $\{111\}$, however, contain alternately only metallic or halogen atoms, and the distance between any two similar planes is $2a/\sqrt{3}$. Now the $\{100\}$ and $\{110\}$ planes reflect the spectra of the various orders with normally diminishing intensities from the first

down to the fifth; but the $\{111\}$ planes show divergencies from normality. Thus, in sodium chloride, the second order spectrum predominates, the first order spectrum being found to be due to planes of chlorine atoms only, and it is reduced owing to the interference of the intermediately situated planes of the lighter sodium atoms. Potassium chloride is unique in showing normal orders of spectra throughout, owing to the atoms being practically all of equivalent diffracting value, as a consequence of their approximately equal atomic weight, the substance behaving in this respect as if it were an elementary one.

In the case of zinc blende, ZnS , the original substance investigated by Laue, the zinc atoms are found to be arranged in the face-centred cubic space-lattice No. 3, while the sulphur atoms lie (*en échelon*) at four of the centres of the eight smaller cubes which together build up the unit cube of the face-centred lattice; each sulphur atom is situated at the centre of a tetrahedron formed by four zinc atoms, which accounts for the hemihedrism of the substance. Both the $\{100\}$ and the $\{111\}$ planes contain alternately only zinc or sulphur atoms, and only the $\{110\}$ planes afford normal reflections of the different orders of spectra, at their respective angles. The planes $\{100\}$ yield predominately even order spectra, while the $\{111\}$ planes show the odd orders more intensely.

In fluorspar, CaF_2 , the calcium atoms likewise

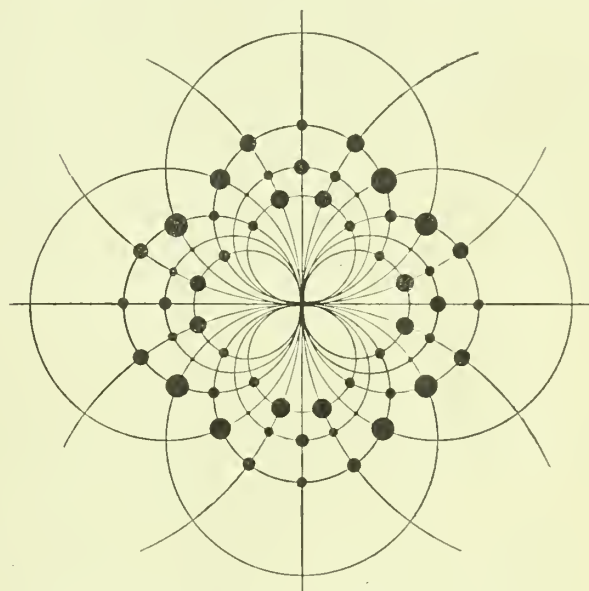


FIG. 4.—SPOT-PATTERN OF POTASSIUM BROMIDE.

form a face-centred cubic space-lattice, but the centres of the whole of the eight cubelets are now occupied by fluorine atoms, and the symmetry is therefore holohedral. Moreover, the two fluorine atoms of atomic weight 19 are found to be equivalent to a single atomic weight of 38, which is almost the same as the atomic weight 40 of calcium; for the planes containing only fluorine atoms, in double

quantity, reflect equally with the planes containing calcium atoms only, and in consequence perfect interferential extinction occurs of the first and other odd spectra from the $\{100\}$ planes, and of the second and other even spectra from the $\{111\}$ planes.

A further beautiful example of the law of proportionality of reflection to atomic weight is afforded by the trigonal rhombohedral calcite group of minerals. The cleavage rhomb is the unit of the space-lattice, an atom of calcium or other replacing metal lying at each corner and at the centre of each face, while the carbon atoms are situated in the middle of each edge. The positions of the oxygen atoms vary in the different members of the series, and this variability of position gives rise to hemihedrism. Perpendicular to the trigonal axis the planes contain alternately calcium atoms alone and groups CO_3 alone; consequently, as the atomic weight of the metallic atoms becomes nearer to the total weight of the CO_3 group (60), the first order

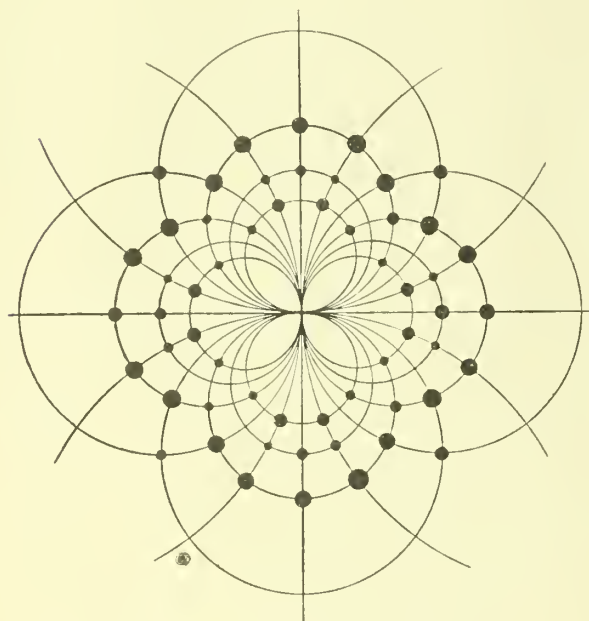


FIG. 5.—SPOT-PATTERN OF ROCK SALT.

spectrum diminishes in intensity, until in the cases of the carbonates of manganese (55) and iron (56), it has vanished altogether. It is further interesting that sodium nitrate, which is well-known to be isomorphous with calcite, affords similar spectra and a like structure is indicated. Moreover, the actual dimensions of the elementary rhomb of the space-lattice of calcite have been measured, and the length of the edge shown to be 6.38×10^{-8} cms.

Finally, the results with the diamond are perhaps the most interesting of all. For it is found that the structure resembles that of zinc sulphide, both the zinc atoms and the sulphur atoms being replaced by carbon atoms. Both the first order spectrum from the $\{100\}$ planes and the second order spectrum from $\{110\}$ entirely disappear. The structure is that of two interpenetrating face-centred space-lattices,

so arranged that each point of the second is surrounded symmetrically tetrahedron-wise by four points of the first. The whole structure is thus a Sohncke regular point-system and not a single space-lattice. This structure accords perfectly with the persistent tetravalency of carbon, and it is also very interesting that throughout the structure groups of six adjacent carbon atoms are always found arranged ring-wise, as will be clear from the reproduction in Fig. 6 of a photograph of a model.¹ These facts afford great confidence to the chemist that the true structure of crystallised carbon in its highest form has now been arrived at.

Indeed, the whole of the results are so wonder

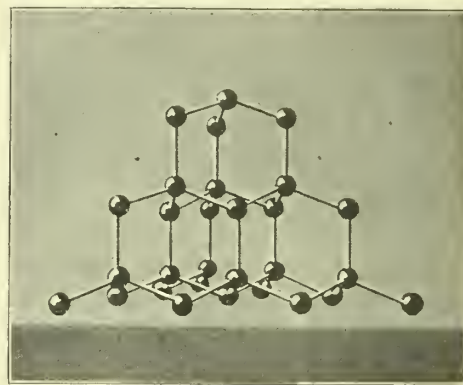


FIG. 6.—MODEL REPRESENTING THE STRUCTURE OF THE DIAMOND.

fully concordant for all the varied compounds studied—showing the accuracy of the assumption that each point of the space-lattice represents a single atom only, and not a group of atoms, and that the main principles on which the conditions are based are sound—that there can be no reason for doubting these interesting results for the diamond.

This structure now indicated displays the diamond as holohedral. In a recent memoir² Professor Pope and Mr. Barlow refer to their valency theory as indicating hemihedrism for the diamond, and state that "the sphenoidal hemihedrism of the diamond is not indicated by the Bragg results." But it would appear to have escaped their notice that in the year 1907, van der Veen showed³ that the supposed hemihedrism of the diamond, which had always been a matter of doubt, is a mistake, and that decisive experiments concerning electric polarity, which resulted in proving its absence, had been carried out by him, which showed conclusively once for all that the diamond is truly holohedral. Hence Mr. Bragg's result is only a further confirmation of the work of van der Veen, and this most beautiful of all known crystalline substances takes its position as possessing the highest possible symmetry, that of the holohedral class (32) of the cubic system.

One further result of very great interest has just

¹ The six illustrations are reproduced from the memoirs of Prof. W. H. and Mr. W. L. Bragg, *Proc. Roy. Soc., A.*, 1913, 89, 248 and 277.

² *Deuxieme Conseil de Physique Solvay*, 1913, "Relation between Crystalline Structure and Chemical Constitution," p. 33.

³ *Kon. Akad. Amsterdam*, 1907, p. 182.

been announced⁴ by E. Jacot, of the South African College, Capetown, namely, that X-rays reflected from the planes of atoms within a crystal are in general polarised. For if they are received on a second similar crystal they can be shown (within the experimental limits as to angles of incident imposed in the case of X-rays) to be again reflected in full or in part, or absolutely extinguished, according to the relative positions of the corresponding planes of atoms in the two crystals, just as is the case with polarised light. If this be fully confirmed the wave nature of X-radiation will have been established.

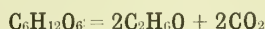
⁴ *Nature*, December 11th, 1913, p. 423.

It will now have been made abundantly clear what a powerful new instrument of research is placed in the hands of crystallographers, physicists, and chemists, and one which will enable not only the crystal structures themselves, but their absolute dimensions to be worked out. The relative measures for isomorphously related compounds afforded by the topic axial ratios may now be translated into actual absolute measures, and the science of crystallography is rendered still more perfectly one of exact measurement, on the scale of minuteness commensurable only with the infinitesimal dimensions of the atom itself.

FATE OF THE GLUCOSE MOLECULE IN FERMENTATION.

By PROFESSOR J. B. COHEN, B.Sc., F.R.S.

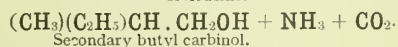
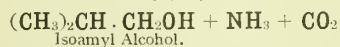
THE nature of the decomposition of glucose on fermentation, which was originally represented by the simple equation—



resolved itself later into a reaction of steadily increasing complexity. For, in addition to the higher alcohols included in the term fusel oil, Pasteur found glycerine and succinic acid to be the regular accompaniments of the process. Since then acetic, formic and other acids, together with various aldehydes and esters, have been added to the list of by-products.

In the last few years new light has penetrated the haze in which the problem has so long been involved by the use of yeast juice in fermentation in place of the living cell. Under these conditions neither fusel oil nor succinic acid is found. This was followed by Ehrlich's discovery of the origin of some of the higher alcohols of fusel oil. He has shown that certain of the amino-acids, which appear during the decomposition of the proteins present in beer wort and grape juice, undergo hydrolysis in presence of the living cells and yield alcohols with loss of carbon dioxide and ammonia, the latter being assimilated and removed.

Leucine and isoleucine, both of which represent fragments of the protein molecule, give respectively isoamyl alcohol and secondary butyl carbinol, which form the bulk of the fusel oil fraction—



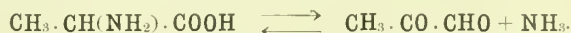
Succinic acid has been traced in the same way to glutamic acid, although the action here is not quite the same. For if the first part of the reaction determines the formation of the alcohol from the

amino-acid, as shown above, an α -hydroxy-acid and not a dibasic acid would be formed, involving thereby a further process of oxidation to complete the change. It has been pointed out that, as yeast contains an oxidase as well as a reductase, no difficulty need be felt in explaining the second stage of the process.

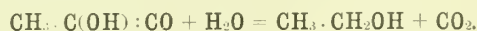
What are the several steps by which these amino-acids are converted into alcohols on the one hand and into acids on the other?

Many explanations might be and have been offered, but the most plausible is the one recently suggested by Dakin and Dudley from the results of their observations on the conversion of alanine into glyoxal.

By digesting nitrophenylhydrazine with a solution of alanine, they have isolated the nitrophenylosazone of methyl glyoxal with the elimination of ammonia, according to the following equation, which they regard as reversible:—



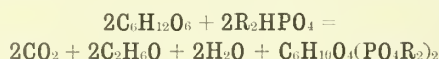
Supposing the methyl glyoxal to undergo isomeric change, taking up a molecule of water and parting with a molecule of carbon dioxide, an alcohol would be formed—



We have only to imagine a similar formation of the corresponding glyoxals to occur in the case of leucine and isoleucine, to account in a satisfactory manner for the two amyl alcohols.

The production of acids will be discussed presently. The higher alcohols being thus disposed of, we have still to account for the glycerine which makes its appearance, when yeast juice is used, to the extent of 3 to 4% of the sugar, as well as to explain the mechanism of the principal change effected during the fermentation of the glucose molecule, namely, the conversion of the latter into ethyl alcohol and carbon dioxide.

Since the discovery of yeast juice, which contains an enzyme or enzymes capable of producing fermentation, the latter process has been brought within the domain of enzyme actions. But although the fermentative process has, in a sense, been simplified by this discovery, it has, at the same time, been complicated by the observations of Harden and Young, who showed that yeast juice may be dialysed to be separated into two substances, an enzyme and a co-enzyme, which must act conjointly to bring about fermentation. Harden has further shown that the initial stages in the decomposition of the sugar molecule are determined by the formation of a hexose phosphate under the agency of an enzyme hexose phosphatase, in which two molecules of hexose take part according to the equation—



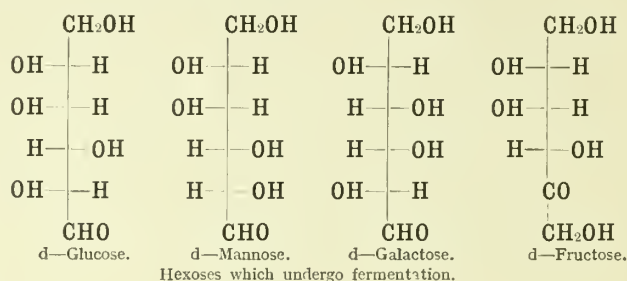
and he further says ("Alcoholic Fermentation," p. 97; "Monographs on Biochemistry," Longmans): "In all the (foregoing) attempts to indicate the probable stages in the production of alcohol and carbon dioxide from sugar, a single molecule of the sugar forms the starting point. The facts recounted as to the function of phosphates in alcoholic fermentation, which are summed up in the equation, render it in the highest degree probable that two molecules of the sugar are concerned.

"The most reasonable interpretation of this equation appears to be that in the presence of phosphate and of the complicated machinery of enzyme and co-enzyme, two molecules of the hexose, or possibly of the enolic form, are each decomposed primarily into two groups. Of the four groups, thus produced, two go to form alcohol and carbon dioxide and the other two are synthesised to a new chain of six carbon atoms, which forms the carbohydrate residue of the hexosephosphate. The introduction of the phosphoric acid groups may possibly occur before the rupture of the original molecules and may even be the determining factor of this rupture, or, again, this introduction may take place during or after the formation of the new carbon chain. Sufficient information is not yet available for the exact formulation of a scheme for this reaction. Such a scheme, it may be noted, would not necessarily be inconsistent with the views of Wohl and of Buchner as to the way in which the carbon chain of a hexose is broken in the process of fermentation, but would interpret differently the subsequent changes which are undergone by the simpler groups which are the result of this rupture."

As Harden states, the reaction involving the double molecule of hexose, is not necessarily inconsistent with the views of Wohl and Buchner as represented by the single molecule, which, being the simpler will now be considered.

If we examine the formulæ of the four natural hexoses which undergo fermentation, using the aldehyde and ketone structure, it is clear that one part of the molecule is reduced at the expense of the other, the latter being thereby oxidised, or, in

other words, that there is a transference of hydrogen in one direction and of oxygen in another to form alcohol and carbon dioxide.

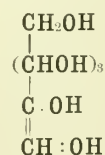


Moreover, seeing that with yeast juice the reaction may proceed out of contact with air, and that the great majority of enzyme reactions are hydrolytic, the natural conclusion—a conclusion adopted by Baeyer and others—is that this transference of hydrogen and oxygen takes place either by the addition and removal of the elements of water, or else by some kind of isomeric change, or, finally, by a combination of the two.

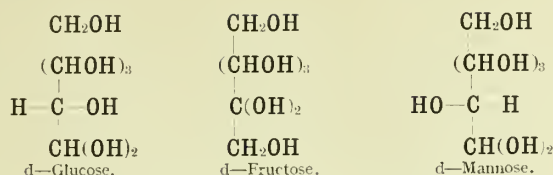
Duclaux was the first to observe the formation of alcohol and carbon dioxide from sugar by the action of alkalis in presence of sunlight. The experiment was repeated by Buchner and Meisenheimer, who obtained as much as 2 to 3 % of alcohol. With more dilute alkali, however, they found that a different reaction occurred and as much as 50 % of the glucose was converted into inactive lactic acid together with a small quantity of formic acid, whilst about 40 % consisted of a complex mixture of hydroxy-acids containing 4 to 6 carbon atoms. Moreover, Buchner and Meisenheimer found occasionally lactic acid among the products of fermentation with yeast juice, though never with living yeast.

Duclaux, who afterwards obtained alcohol and calcium carbonate from calcium lactate in sunlight, was led to regard lactic acid as the direct, and alcohol and carbon dioxide as indirect, products of disintegration; and the same view was at one time adopted by Buchner and Meisenheimer until they and Sator proved by very careful experiments that lactic acid was incapable of fermentation either by living yeast or yeast juice.

Let us inquire further into the formation of lactic acid. Lobry de Bruyn found that dilute alkalis, alkaline earths, and a few other metallic oxides convert any one of the three sugars, d-glucose, d-mannose, and d-fructose, into a mixture of the three, and the change has been ascribed to the intermediate formation of an enolic form—

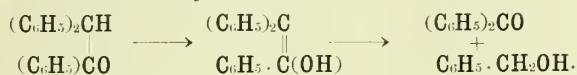


which, by the addition and subsequent removal of a molecule of water, gives one or other of the above three substances.

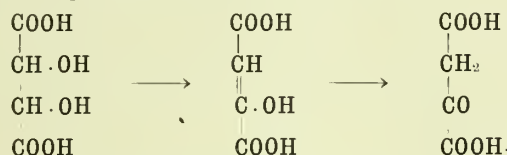


Here, then, we have an isomeric change from keto to enol form in two directions (one in glucose and mannose and another in fructose) followed by the addition and subsequent removal of a molecule of water. Glyceric aldehyde, and dihydroxy-acetone undergo, as Meisenheimer found, a similar isomeric change under similar conditions.

That such a reaction is not uncommon is shown by the fact, recently discovered by Mr. J. Marshall and privately communicated to me, that phenyl desoxy-benzoin breaks up spontaneously into benzophenone and benzyl alcohol.

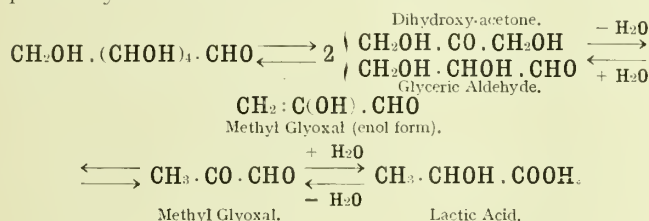


The reverse process has been observed by Wohl in the case of tartaric acid, which can be converted into oxalacetic acid in which isomeric change follows instead of precedes the removal of water.



There seems little doubt, therefore, that such a process is a reversible one.

Applying it to the conversion of glucose into lactic acid after the manner of Wohl we shall have the following series of changes all of which are probably reversible:—

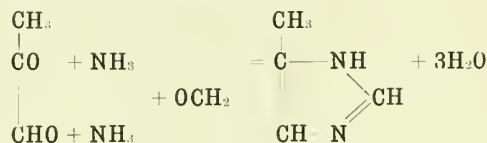


What evidence is there of the depolymerisation of the sugar molecule into two molecules of glyceric aldehyde (or dihydroxy-acetone) and of the intermediate formation of methyl glyoxal? The reply to the first is that glyceric aldehyde and dihydroxy-acetone may be condensed to form a hexose, and it may be confidently assumed that under appropriate conditions reversal occurs,¹ to the second, that lactic acid occasionally appears when glucose is fermented with yeast juice, and that Levene and Meyer have proved that leucocytes convert d-glucose, d-mannose, and d-fructose into d-lactic acid, and can also transform methyl glyoxal

into a mixture of inactive and d-lactic acid. Further, Wohl found that in alkaline solution methyl glyoxal readily passes into lactic acid. The reverse change has been shown to occur by Mandel and Lusk, who found that lactic acid, when administered to diabetic animals is converted into glucose, and by Dakin and Dudley, who found that both methyl glyoxal and d-lactic acid are similarly transformed into glucose. The relation between glyceric aldehyde and dihydroxy-acetone on the one hand and methyl glyoxal and lactic acid on the other, has been demonstrated by Embden, who showed that the two former undergo conversion into lactic acid in the liver, and by Meisenheimer, who found that the same two substances are transformed into methyl glyoxal on heating with dilute sulphuric acid.

The formation of methyl glyoxal from glucose has been proved in various ways.

Knoop and Windaus found that when zinc ammonium hydroxide acts upon glucose in sunlight at the ordinary temperature, a large quantity of methyl iminazole is produced, and the production of this substance is readily explained on the assumption of the intermediate formation of methyl glyoxal and of formaldehyde.



In presence of acetaldehyde dimethyliminazole is formed. The formation of methyl glyoxal from glucose has also been shown by Pinkus, who obtained the phenylosazone by acting upon glucose in presence of phenylhydrazine, and by Dakin and Dudley, by distilling a glucose solution with sodium phosphate, when methyl glyoxal was found in the distillate. Moreover, Dakin and Dudley have shown that when a solution of lactic acid is digested at 37° in presence of nitrophenylhydrazine, the nitrophenylosazone of methyl glyoxal is precipitated and that, on the other hand, methyl glyoxal yields lactic acid by the aid of glyoxalase, an enzyme recently discovered by them in various tissue extracts and blood cells.

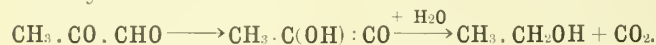
Incidentally it may be observed that, as alanine gives methyl glyoxal by loss of ammonia it might be expected to yield glucose, and both Lusk and Ringer, as well as Dudley and Dakin, have shown that glycosuric animals convert many amino acids into glucose. The contrary process, that is, the formation of ketonic aldehydes may, therefore, represent the first step in the metabolism of amino acids.

Thus the chain of reversible reactions between glucose and lactic acid is nearly complete. The only missing links are the direct proof of the presence of glyceric aldehyde or dihydroxy-acetone and the reversibility of the glyceric aldehyde and methyl glyoxal change.

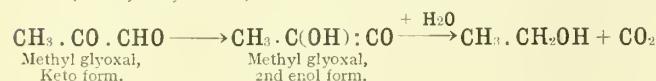
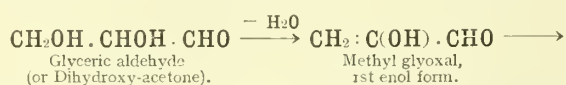
Assuming, for the sake of argument, that all the above changes have been completely demonstrated, we have to determine which products form

¹ The supposed isolation of the methylphenylosazone of dihydroxy acetone recently announced by Boysen Jensen, has been adversely criticised by Buchner and Meisenheimer. A. Fernbach, on the other hand has observed the disintegration of glucose by living schizomycetes (*tyrothrix tenuis*) and its press juice into dihydroxy-acetone.

the precursors of alcohol in fermentation. The formation of alcohol and carbon dioxide from methyl glyoxal has been explained by Dakin and Dudley by supposing isomeric change to take place between the aldehyde and ketone group, and to be followed by the addition of the elements of water, a reaction precisely similar to that observed by Marshall, and already referred to.

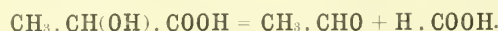


Thus, methyl glyoxal furnishes an important link between glyceric aldehyde or dihydroxy-acetone (which are mutually convertible like glucose and fructose) on the one hand and alcohol on the other, the only assumption being that methyl glyoxal is capable of isomeric change in two directions after the manner of the hexoses.



An important question still remains to be answered. If glyceric aldehyde or dihydroxy-acetone and methyl glyoxal represent intermediate stages in the process of fermentation, they should be attacked alike by yeast or yeast juice. Buchner and Meisenheimer have tried the action of yeast and yeast juice upon the three substances in question and found that whilst dihydroxy-acetone is rapidly fermented (though much less rapidly than glucose), glyceric aldehyde is fermented slowly, whereas methyl glyoxal is not fermented at all.¹ At first sight this observation might appear to negative the view that methyl glyoxal is the real precursor of alcohol; but it may be, as Dakin and Dudley point out, that the presence of glyoxalase, which they found in yeast, may affect the process by transforming some of the methyl glyoxal into lactic acid. Until further experiments have made it quite certain that under no conditions is methyl glyoxal fermented by yeast, this attractive hypothesis, which has been put forward by Dakin and Dudley, seems to be the most plausible that has so far appeared.

There is another view of fermentation, first suggested by Schade, in which lactic acid is made the precursor of alcohol, breaking up, as it is known to do with dilute sulphuric acid, into acetaldehyde and formic acid.



By the action of metallic sodium on these two products, formic acid is converted into hydrogen and carbon dioxide, and Schade found that this

liberated hydrogen reduces the aldehyde to ethyl alcohol. He suggests, therefore, that in fermentation acetaldehyde and formic acid may appear not necessarily from lactic acid; but from some labile substance yielding these two products.

Now, Neuberg and his co-workers have found that yeast contains an enzyme called *carboxylase*, which splits off carbon dioxide from α -ketonic acids. Thus, pyruvic acid breaks up into acetaldehyde and carbon dioxide.



In presence of glycerine and pyruvic acid the yield of alcohol is enormously increased. From 170 grms. of alcohol obtained from the autofermentation of 22 kilos. of yeast the amount rose to 626 grms. when a kilogram each of pyruvic acid and glycerine were present. They look upon the glycerine as having merely an indirect action as an enzyme preservative and thus enhancing its reducing power. In confirmation of this they have obtained in the same way propyl alcohol from α -ketobutyric acid and by fermenting sugar in presence of isobutyraldehyde they have found a considerable quantity of the corresponding alcohols, in the latter case as much as 85 % of the theoretical yield.

NOTE ON THE DETECTION OF CARAMEL IN NON-SACCHARINE SPIRITUOUS LIQUORS.

By ARDESHIRE K. TURNER, Assistant Surgeon, Government Laboratory, Byculla, Bombay.

To carry out this new test for the detection of caramel, 25 c.c. of the sample may be taken and placed in a glass capsule and evaporated to dryness on a water bath. About 5 c.c. of a solution of hypobromite of sodium is then added, when the residue will go into solution. This is then transferred to a small test tube and allowed to stand for five minutes when a white precipitate will form and fall to the bottom of the tube. This precipitate is then examined under a $\frac{1}{4}$ -in. power when innumerable small bodies resembling dumb-bells in shape will be seen lying alone or upon one another. On closer inspection these dumb-bells will be found to be made up of fine needles arranged in bundles or sheaves.

To illustrate the delicacy of this test the following case may be cited—a sample of coloured spirit (containing approximately 78 % proof spirit) was taken for analysis:—

The extract from 25 c.c. (0.035 %) was treated as above, and numerous "dumb-bell" shaped bodies were observed under the microscope. The reaction is due to the oxidising action of the hypobromite on the caramel or burnt sugar (see my paper on "A New Test for the Detection of Saccharine Substances in Urine," *CHEMICAL WORLD*, June 1st, 1913), whereby the latter is converted into oxalic acid.

The value of this test is seen in the fact that this same sample of spirit, gave no reaction with Fehling solution, even at the boil.

¹ Buchner and Meisenheimer were led from these experiments to regard dihydroxy-acetone and not glyceric aldehyde or methyl glyoxal as the precursor of fermentation, and explain the inactivity of lactic acid obtained from the former by reason of its symmetrical structure. An equally satisfactory explanation might be found in its formation from methyl glyoxal, which contains no asymmetric carbon atom. Lebedew's suggestion that dihydroxy-acetone first undergoes synthesis to a hexose-phosphate is met by the fact that such a sugar would be an inactive mixture, and that only one active form could be fermented, whereas 90% is transformed.

CHEMICAL INDUSTRIES.

A Monthly Review of the Progress of Technical Chemistry.

OILS, FATS AND MILK PRODUCTS.

By CECIL REVIS and E. RICHARDS BOLTON.

KAPOK oil, an oil perhaps not very generally known but which is very probably unwittingly used by many manufacturers under the name of cotton-seed oil, seems to have received some special attention from the analytical world lately.

Sprinkmeyer and Diedrichs (*Zeit. Untersuch. Nahr. Genuss.*, 1913, 26, 86) have published a useful series of figures for seeds obtained from most of the chief growing centres, and point out that the oil obtained from the true plant, *Eriodendron anfractuosum*, is often confounded with the product of *Bombax malabaricum*, though, in fact, in commerce the seeds of the latter plant are commonly known as Kapok seeds. The analyses of these observers show distinctly different figures for the two oils for several values, in particular for those for the iodine value and refractometer readings. They are also of opinion that Millau's test is, as has been pointed out by the writers ("Fatty Foods," p. 221), quite distinctive for this oil as compared with cotton-seed oil.

A similar examination of these seeds and oil has been carried out by Matthes and Holtz (*Arch. Pharm.*, 1913, 251, 376). The figures obtained by these observers are very similar to those given in the foregoing reference, and the value of the paper is enhanced by a very careful description of the seeds.

We take this opportunity of drawing attention to the difference in the values obtained by these latter observers for "extracted" and "expressed" Kapok oil, as little attention is often given by analysts to this only too common phenomenon in manufactured oils, which may account for the unfortunate discrepancies which sometimes arise between different observers.

The Imperial Institute have published in their *Bulletin*, No. 11, 1913, p. 226, the results obtained for five samples of cohune oil, which, according to our experience, are fairly normal, and the value of the paper is rendered greater by the careful description of the nuts, etc.—a care which always characterises the publications of this department.

Attention is drawn in it to the fat obtained from the outer fibrous layer of the husk, which fat has probably hitherto escaped the attention of many, and we believe this to be the first published record of any analysis, and the comparison drawn, from an analytical point of view, with crude palm oil, we can fully confirm. The high acid value, consistency and general characteristics bear out this statement in particular.

As cohune nuts appear likely at any moment to become of the greatest commercial importance, such papers are of distinct interest. A large output of cohune oil at the present moment would be of great value in reinforcing the already over-taxed supply of coconut oil.

A long and interesting piece of work has been carried out by Beerbohm (*Milch Zentralblatt*, 1913, 42, 513) on the variations in the Reichert-Meissl and Polenske figures for

butter made from the fat of milk obtained from single cows over the whole lactation period. The paper, which is illustrated with numerous curves, shows that the Reichert-Meissl and saponification values and the refractometer number follow one another, and show a steady decrease during the period of observation, while the Polenske value on the other hand shows a steady increase.

In our last article we had cause to draw attention to a paper by Grimme (*Chem. Rev. Fett. Ind.*, 1913, 20, 129), in which certain tests for hardened marine animal oils were given; this has been followed by a further paper (*ibid.*, p. 155), in which he points out that a solvent consisting of equal parts of benzene and xylene renders these tests more valuable.

As the phytosteryl acetate test is of much greater importance than it has been in time past, Circular 212, of the U.S. Department of Agriculture, Bureau of Animal Industry, May 10th, 1913, dealing with the practical working of this test is of interest; but there is no doubt that the digitonin method of obtaining these sterols from fats, so greatly simplifies the analytical manipulation that, if subsequent investigation should show the complete reliability of the method, it will displace all others, though at the moment the high price of the necessary reagent is a little prohibitive.

In the above connection Hieduschka (*Eighth Inter. Cong. App. Chem.*, 1912, 11, 13) has stated that phytosterol obtained from sesamé oil is a perfectly definite compound.

Some useful qualitative tests which may possibly have a bearing on fat and oil analysis are those by F. H. Rhodes (*J. Ind. Eng. Chem.*, 1912, 4, 652) for hydrogen cyanide, and by Schmidt (*Zeit. anorg. Chem.*, 1913, 80, 335) for palladium. This latter may possibly be of use in connection with hardened fats, as the author states that it will detect 0.001 grm. per litre.

The ever knotty subject of rancidity in fats has been once more investigated by Wagner and others (*Zeits. Untersuch. Nahr. Genuss.*, 1913, 25, 704), the investigation extending over a period of more than two years. The anhydrous fats were exposed to direct sunlight in an atmosphere of nitrogen, but, in spite of this, they in all cases showed a decided increase in acidity, though the other analytical figures did not show anything but the smallest alteration. At the same time a decided rancidity was developed so that the presence of air is not essential to the production of this change.

To those interested in milk products, Bulletin No. 162, of the U.S. Department of Agriculture, Bureau of Animal Industry, on "The Factors influencing the Change in Flavour of Storage Butter," should contain points worthy of note, particularly as the fall-off of the flavour which nearly always occurs in cold storage is a difficulty which greatly affects the butter industry, and any light on this question is to be welcomed.

Boekhout and de Vries (*Cent. fur Bakt. Abt. II*, 1913, 38, 462) have investigated a cheese fault which they term *Kruypers*, which arises in Edam cheese apparently from the

activity of butyric acid organisms. The cheeses so affected become filled with crevices and give a hollow sound when struck and the fault may be corrected or largely ameliorated by the addition of potassium nitrate.

The dominant activity of *Penicillium roqueforti* in Roquefort cheese is due, according to Thom and Currie (*Jour. Biol. Chem.*, 1913, 15, 249) to the low percentage of oxygen which occurs in the fissures of the cheese.

Just recently there seems to have been considerable discussion as to the best method for the estimation of fat in cheese. A full criticism of available methods has been made by Utz (*Milch Zentralblatt*, 1913, 42, 457), the conclusion arrived at being that the Ratzliff-Schmidt-Bondyzinski method (which is a combination of the Werner-Schmidt and Gottlieb methods) appears to give the most satisfactory results. The Polenske method which is very similar, the chief difference being that sulphuric acid is substituted for hydrochloric acid, comes second though the usual centrifugal methods of Gerber and others are sufficiently accurate for ordinary commercial control purposes.

The already large number of soured milk products which have been recently brought to the notice of the scientific world has been increased by Gorini (abs. *Milch Zentralblatt*, 1913, 42, 369), who describes the soured milk of Servia and Montenegro which is termed *Skorup*. It appears, however, to differ but little, if at all, from the well-known *Yoghurt*.

The *Bulletin de la Stat Laitière*, No. 29, 1912, of the Ministère de l'Agriculture de Belgique contains in its bibliographic index, 1911, the world's literature concerning milk products.

TREATMENT OF WATERS CONTAINING IRON OR MANGANESE.

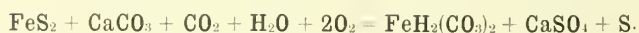
By Drs. S. & E. RIDEAL.

THE amount of iron present in natural waters varies widely from the ordinary mere trace to from 30 to 70 mgs. per litre (parts per million) in sources that have been used as potable; higher quantities are medicinal. In these waters it ordinarily occurs dissolved in the ferrous state as bicarbonate, which absorbs oxygen from the air and produces ferric hydroxide, liberating carbonic acid, according to the equation:—



Part of the iron is deposited in crusts or sediment; part remains suspended or colloidal and renders the liquid turbid, and a part stays in solution, so that the liquid retains a brown red colour. The carbonic acid liberated in the above equation is evidently free to act again on metal or rock.

Iron pyrites, FeS_2 , in presence of carbonate of lime, carbonic acid, oxygen and water may slowly change as follows:—



A complete oxidation also occurs to sulphate of iron and sulphuric acid, which appear in many mine waters, rendering them acid as well as ferruginous. These chalybeate waters are frequently associated with manganous bicarbonate; it is fortunate that iron in small quantities has no marked effect on health, as besides being contributed by

soils or rocks, it is also often added by being dissolved from pipes and tanks. Dr. Thresh remarks ("Water and Water Supplies"), "although I have never heard of any ill effects following the continued use of a water containing a trace of iron, I should expect headache and constipation to be produced amongst those accustomed to its use." To ascertain whether the ferruginous character is natural or accidental, a sample must be obtained direct from the source, and in the use of deep wells by pumping vigorously for some time. To lay down permission limits for its quantity in supplies involves not only considerations of potability, but of course industrial applications, since it affects many dyes and natural colours, and is injurious in several manufactures. In washing, besides acting as hardness and using up soap, it stains the clothes with "iron-mould." It also stains paper and other light-coloured materials. Speaking on all the aspects, H. Schwes observes (*Rev. d'Hyg.* 30, 11) that "inconveniences from iron appear sometimes to commence when the content reaches 0.1 parts of Fe per million; commonly, however, when it rises over 0.2 to 0.3 parts. With 0.1 to 0.3 parts, a deposition of iron hydroxide occurs on standing, and such a concentration is found most favourable to the growth of iron bacteria which may block up the pipes, also at this point the water takes up a chalybeate taste, and becomes unsuitable for washing and many industries." Therefore he considers that iron removal begins to be necessary at a content of 0.1 to 0.3 parts of Fe per million, according to the water. In America, Hazen's permissible limit for public supplies is 0.5 parts of Fe per million.

O. Spitta says (*Handbuch der Hygiene*, p. 18, 1911), "when iron is over 1 part per million most people can taste it very distinctly." Trials in our laboratory showed that only one out of ten persons could notice any difference of taste with water containing 0.5 parts per million of iron, but 1 part per million was distinctly perceived by all, particularly in the after taste.

The growth accompanying the use of an iron containing water has often proved a great source of trouble in waterworks—as at Rotterdam, Berlin, Cheltenham and elsewhere. The organisms that are peculiar to waters containing iron acquire membranes covered with a coating of ferric hydroxide giving them a brownish-red appearance. Such species as have the power of secreting metals such as iron, aluminium or manganese are said to be *Chemiotactic*. Molisch growing certain of them in iron-free media, proved that, in the absence of iron, manganese was attracted. The method of deposition is not clear; Zopt considers it to be a purely mechanical action, while Cohn compares the decomposition of iron hydroxide to that of silica in diatoms, etc. Winogradsky believes that the energy derived from the chemical oxidation of the ferrous hydrogen carbonate to ferric hydroxide, provides the necessary energy for the growth of the organisms. The usual organisms of this class, *Crenothrix*, such as *Chlamydothrix*, *Clonothrix* and *Gallionella*, frequently appear as long threads or a tough network of rods, which often mat together and clog up pipes and mains.

As mentioned above, iron can be thrown out of solution by the action of atmospheric oxygen on the ferrous bicarbonate. Darapsky (*Enteisenung von Grundwasser*) shows that this action "takes place most readily, and possibly only to any extent, in the presence of a catalyst." The best catalyst is some finely divided absorbent surface. These conditions are completely fulfilled by the so-called oxidising filters, which are consequently used for treating

ferruginous waters. There are other types of apparatus which are exclusively employed for removing iron.

The behaviour of the iron is much influenced by other substances accompanying it, which sometimes greatly hinder processes of separation. Highly ferruginous waters are often easier to treat than those containing comparatively small quantities of iron, as the result depends upon the character of the water and the state of combination of the metal. Accordingly deferrisation processes may be classified as—

- (A) Those adopted when simple aeration is sufficient.
- (B) Classes where lime has to be used as an adjunct.
- (C) Colloid removal by agglutination.

On account of the fineness and colloidal nature of a part of the iron precipitate, simple settlement takes such a long time that filtration is an ordinary sequel in each case.

(A) The process of aeration is assisted by passing over step cascades, by showering through perforated plates or by centrifuges. Another ingenious device is a specially constructed pump which delivers a mixture of air and water at the same time through a small sand filter.

Dunbar uses an iron cylinder containing sand in grains of 1 to 1.5 mm. diameter, repeatedly emptied and filled; he finds that when once the sand grains have obtained a thin coating of ferric hydroxide the filter prevents any more iron from passing through. The filter must be emptied every night to admit of air circulation among the interstices of the sand grains. The principle includes agglutination, further utilised in our Class C. Similarly coarse filters made as beds or towers filled with coke-breeze remove iron, probably by accretion to the iron compounds already contained in the coke, and the use of other materials such as clinker or wood shavings is more or less successful. In some places the air is forced in under pressure in a closed chamber, with the advantage that the atmospheric oxygen dissolves and acts more rapidly and the water is protected. Chemical oxidisers like ozone, bleaching powder, and permanganate remove iron, and at the same time disinfect.

(B) The dissolved iron may be in combination with mineral acids as in some mine waters and trade effluents, or with organic bodies and acids of the human group as in peaty sources, or there may be a large excess of carbonic acid. In each of these cases simple aeration is not sufficient for complete precipitation and slaked lime must be added along with the aeration (not forgetting the effect on the hardness); in addition this has a certain amount of agglutinating power as seen in the "excess lime" process used for water purification.

(C) Special agglutinants or coagulants such as alum are sometimes required for deferrisation; the iron is here removed by adhering to the gelatinous precipitates of hydrated alumina or of iron hydroxides. Kronske states that he obtains the best results with ferrous chloride and lime. Hess and Linde use a deposit of hydrated oxide of tin and wood as a mordant and carrier of oxygen.

Humous bodies can themselves act as agglutinants, and for this purpose it has been proposed to mix the ferruginous water with a suitable quantity of brown and peaty water. In some instances precipitation results, but in most the remedy would be worse than the disease.

In the case of manganese, which in bog ore is closely associated with iron, no special toxicity is observed, but it caused similar inconveniences, and its removal by the ordinary processes are slower and more difficult. Besides the discoloration and turbidity caused by manganese hydroxides, they encourage the growth of a *Crenothrix*, in

this case the sub-species or variety *manganifera*. Demanganation can hardly be effected without heating, or the addition of some assisting chemical. Lately the "permutit" system has been applied to the removal of both iron and manganese.

THE MEXICAN GRAPHITE DEPOSITS.

GRAPHITE is a somewhat rare mineral, and is only found in quantity in a few localities, one of which is Mexico. The conditions of its occurrence there, roughly correspond with those of its occurrence in this country, suggesting that it is due to the same causes. The Mexican deposits, as well as those in the Lake District, are found in the older sedimentary rocks, and probably represent the remains of an extremely old vegetation. In both cases, volcanic rocks occur in close vicinity, which have subjected the sedimentary rocks and their mineral contents to intense and prolonged heat, with the result that what might have become some type of coal, has been turned into graphite, popularly known as black lead. The average composition of the Mexican graphite is as follows:—

					9%
Carbon practically graphite	..	..	..	..	85.70
Silica, SiO ₂	..	..	..	..	7.65
Iron oxide, Fe ₂ O ₃	..	..	..	..	0.65
Alumina, Al ₂ O ₃	..	..	..	..	5.00
Impurities	..	..	..	..	1.00
					100.00

Pockets occur of exceptionally pure graphite, ranging up to 95%, and there are inferior qualities with a considerable percentage of impurities. Oddly enough, the hills overlooking the Mexican mines are not unlike in appearance the Cat Bell range of the Lake District, along which the Cumberland deposits were found, which enabled a small black lead industry to be developed in Keswick, approximating to the very large and important Mexican industry. The Mexican hills are rounded with well-marked summits, and rise somewhat abruptly from the undulating plain, covered with rank scrub and vegetation. They present features of interest, which the average traveller, even without expert geological knowledge, can readily grasp. The hill tops are all lava, which has preserved them from denudation, precisely as the Clee hills in Shropshire have been preserved by a capping of hard basalt. These lava flows are still bounded by somewhat abrupt precipices. A few cones still occur in the neighbourhood, suggesting the volcanoes, or vents from which these lavas were poured. Below them, more in the plain, are the rocks containing the graphite deposits. They consist of what were once sand and mud banks, the graphite probably representing land surfaces with vegetation. These rocks have all the appearance of having been subjected to great heat; the boulders lying about the shafts of the graphite mines suggest that. Further afield, limestone occurs; the probability is therefore strengthened that these graphite deposits are in reality coal seams, which have been altered by local conditions. A very similar succession of rocks can be seen in the north of England. The rock containing the deposits is comparatively soft, and can be readily worked with a pick; so far, seven layers of graphite rock have been met with, and there are, as is common in coal beds, lenticular masses of sandy

material between the workable graphite; further away from the volcanic rocks, ordinary coal, coke and anthracite have been found. It follows that it may always be advisable to search for graphite, wherever coal-bearing rocks abut on, or are overlain by lavas. The several beds of graphite vary very much in thickness and quality, one of them now being worked has a depth of 9 to 10 ft.; it is irregular in strike, and more or less S-shaped, due to the lateral pressure which it has been subjected to. These folds cause some complication in working the deposit, as they also occur along the dip; occasionally the vein is almost completely squeezed out, or greatly reduced in thickness, the material having been pushed forward so as to swell out, to a corresponding extent, other sections of the vein. There is no loss of graphite; only a displacement, and consequently more complication in working. Thus a so-called pocket was found nearly 8 yds. thick, 25 yds. in width, and nearly double that in length. The miners whilst removing the graphite have in places actually exposed the lavas, the heat of which must have turned the original coal into graphite; in other respects, the surrounding rock does not materially differ from that of an English coal mine. When the graphite and the surrounding rock are more or less intermingled, the miners have no difficulty in separating the former; this intermingling is due to the volcanic disturbances and pressure the district was once subject to.

The appearance of graphite is well known; it has a grayish-black lustre, which any traveller with ordinary observation would recognise; it may be described as sub-metallic, and is relatively soft; anyone visiting the Mexican mines can readily break it up, even with his hand; moreover, the material has a soft, velvety touch and is quite smooth. When a large lump is examined, parallel lines may be noted across it similar to those seen on many lumps of coal picked up haphazard. Many of the difficulties of mining harder materials elsewhere do not occur at the Mexican mines, thus explosives are not used at all; the task of getting the graphite is more like that of working a very stiff clay. After being dug out, it is hauled up and merely spread out in shallow heaps, so as to be dried by the heated atmosphere, and is then piled up and ready for removal. These graphite deposits occur in the State of Sonora, which forms the extreme north-west of Mexico, with a coast line to the Gulf of California, from which a line of railway extends into the United States. The district surrounding the mining area is extremely desert-like, with a very limited rainfall; the mines may be reached from La Colorada, the western terminus of a narrow-gauge railway starting from Torres, which is a station on the Sonora section of the Southern Pacific Railway. The distance of the mines from Colorada is about 21 miles, along a reasonably good road through entirely uninhabited and waterless country, as the limited rainfall is crowded into three months of the year, July, August and September, during which vegetation has only a brief span of existence. The mines are worked with some difficulty owing to the lack of water, all the year round. They are the most extensive of the sort on the North American continent, with also the largest output of graphite. They have been entirely developed by American capital; the mines are known as the Santa Maria graphite mines. More than three-fourths of the black lead required for the world's supply of lead pencils has been obtained from these mines since about 1895. The material is of great use in many of the arts and trades, and there is a considerable demand for it, which may be expected to increase. It has been found serviceable in the manufacture of lubricants, paints, foundry facings, electrotyping, for stove polish and

many other purposes. As the graphite is found in a very pure state, only a limited amount of preparation is necessary to render it fit for the market; it is first ground and then separated from refuse by mechanical means. The deposits have been known about forty-five years. When first discovered there were no railroads in the vicinity, and there was little demand for the material, they were therefore neglected. Renewed attention was drawn to them about twenty-two years ago, the district was carefully explored by experts, and some expense incurred to ascertain their extent and the quality of the material. The reports were very favourable and have proved reliable, capital was readily obtained, and the deposits were opened out on a large scale about eighteen years ago and have been continuously productive ever since.

The main mine shafts and the buildings used by the management are on a slight elevation about 100 ft. above the plain, and approximately 12 to 1,300 ft. above sea level. There are two shafts about 1,000 ft. apart, one to the west, and the other to north-east. At present seven beds of graphite are known, of which six occur in the north-east shaft, and it is reasonable to suppose that with increased depth others may be disclosed, so long as the present type of rocks continues. As in an English coal mine, all the surroundings of the shafts are coated with the fine dust of the material, including the men's faces, hands and clothing, only that instead of the dull black of the coal dust, there is the metallic lustre of the graphite. A notable point in these mines is the rapid rise of temperature in the workings, which are as yet very shallow; it is very much greater than in most other mines; the miners consequently work stripped to the waist.

The west shaft is not actually vertical, but inclined at an angle of about 50 degs., with workings about 25 ft. apart, and the total depth reached is about 200 ft. The other shaft is inclined at an angle of 72 degs. and is about 150 ft. deep, with levels 50 ft. apart; one of the graphite seams cut by this shaft has an average thickness of 5 ft. and another of 3 ft. Two others are respectively 2 ft. and 1 ft. thick. The deposits were originally found by outcrops along the bottom of the hills, not far from the present shafts. In these mines the cost of output is increased by the necessity of using a considerable quantity of timber to support the roofs of the workings, owing to the very shattered nature of the rocks. Another difficulty is the scarcity of water; a considerable supply is required both for the men and for stock; the limited quantity available, obtained by pumping from specially sunk wells, is served out daily in carefully regulated quantities. The graphite has to be carted to Colorada along the 21-mile road mentioned above, by mules, ten or twelve to each waggon, which bring back the stores and food supplies required. Native labour is largely relied on, as it is not affected by the intense heat of the summer; during the winter, the temperature is moderate, and not subject to great extremes. Those engaged in the mines, with the management, form a small self-contained and isolated community, comfortably housed, with considerable live-stock, and are now reasonably safe from inroads both of Indians and marauders.

THE Bulletin of the Imperial Institute, October—December, 1913, contains many reports of considerable interest on the utilisation of para rubber seeds, little-known oil seeds, tobaccos from the East Africa Protectorate, etc. Also special articles on the Canadian Department of Agriculture and Agriculture in Northern Nigeria.

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

CHAPTER I. (*continued*).

(6) EFFECT OF ADDITIONAL SUBSTANCES UPON CATALYSTS.

(a) *Poisons*.—It is a curious and important fact that the activity of a catalyst is liable to be greatly diminished by the presence of another substance, of which even a trace is often sufficient to paralyse the catalyst. The classical instance of such an *anti-catalyst* or *poison*, as they are called, is taken from the manufacture of sulphuric acid by the Contact process, where at the very outset it was found that the platinum asbestos employed for the oxidation of sulphur dioxide, deteriorated so quickly as to render the process unworkable. Happily, the threatened ruin of this rising industry was averted by the discovery that it was the arsenic and other impurities contained in the sulphur dioxide which clogged the pores of the platinum and accounted for its diminished activity. Similarly, in the recent synthesis of ammonia by Heber the presence of poisons contributed greatly to the difficulties involved in the establishment of the process on a commercial basis.

In all cases, the effect is remarkable for the smallness of the quantity of poison required for rendering the catalyst inactive. In the last-mentioned process, for instance, the iron used as catalyst becomes quite "dead" when it contains $\frac{1}{10}\%$ sulphur, and is of little use with $\frac{1}{100}\%$ impurity even.

Arsenic seems to paralyse the action of most catalysts. The same applies more or less to prussic acid, mercuric chloride, iodine, etc., though each catalyst usually has its own list of poisons. Some of the poisons for the iron of Heber's synthesis, for instance, are of quite a different nature from those of the platinum in the sulphuric acid manufacture. In some cases, especially when the inhibitor is oxidisable, the catalyst may recover its activity; in the remaining cases, the catalyst must either be discarded or its paralysis prevented by careful purification of the reacting materials.

Enzymes, which are also catalysts, are subject to a similar inhibiting influence, often by the same substances that poison purely "inorganic" catalysts. The phenomenon is to be observed also in blood catalysis, where the antitoxins oppose the destructive effect of the toxins upon the blood.

The action of catalytic poisons should not be confused with that of negative catalysts. In the latter case it is the reaction which is retarded, whereas in the former the catalyst has its activity reduced.

(b) *Promoters*.—In contradistinction to the above-mentioned inhibiting substances, it has recently been discovered that there are other substances which, when added in minute quantity to a catalyst, *increase* its activity. Thus, practically all metallic catalysts become activated when certain oxides or compounds or other metals are distributed through them. In Haber's synthetic ammonia manufacture, for instance, the iron, platinum, osmium or uranium employed as catalyst is quickened to an enormous extent by the presence of traces of the salts of other metals or, with certain exceptions, of the other metals themselves. Further research in connection with these *promoters*, as they are called, would be amply repaid.

When the additional substance does not catalyse the main reaction, but rather the production of the catalyst, the phenomenon has been referred to as *Pseudo-catalysis*. A technical example is furnished by the drying of linseed-oil, where the addition of the so-called siccative, such as the oxides of manganese, lead or zinc, is found to hasten the process, probably by accelerating the development of the peroxide-like compounds which determine the drying (Genthe).

It may be noticed here that the joint effect of two catalysts need not necessarily be the sum of the effects of each catalyst taken separately. Though this does sometimes hold, the joint effect is more often greater and only occasionally less.

(7) SPECIFIC ACTIVITY OF CATALYSTS.

As Ostwald has pointed out, there is probably no kind of chemical reaction which cannot be influenced catalytically, and no substance which cannot act as a catalyst. Yet each reaction requires its own specific catalyst or catalysts. True, under Armstrong's theory, water or some other electrolyte is essential to all chemical reactions, but experiment is against this generalisation. There are, moreover, particular catalysts, such as platinum and nickel, which appear capable of manifold application and theory has speculated much upon their *modus operandi*, but in point of fact, no general method is available by which guidance is offered in the selection of a suitable catalyst for a given reaction. Occasionally, the discovery of such a body is a matter of accident or good fortune, as in the case of the manufacture of artificial indigo, where the accidental breakage of a thermometer liberated the catalyst which rendered practicable the most obstinate reaction of the process. More generally, however, before the commercial success of a catalytic process is assured, years of systematic scientific research with all manner of likely catalysts are involved.

CLASSIFICATION.

For the purpose of convenience, catalytic agents may be broadly divided into three classes:—

(1) Chemical agents, which function by means of intermediate reactions. The so-called *carriers* fall into this class, as well as the catalysts of what are known as “cyclic actions.”

(2) Physical agents, such as finely-divided materials in general, hot and cold surfaces, etc., in which the effect is dependent upon surface tension, occlusion, diffusion, or other physical phenomena.

(3) Indeterminates, which appear to combine more or less the above two functions. Enzymes probably fall into this division.

A classification of this kind is naturally only a provisional one, for it is not certain in many cases how the catalyst does function. Indeed, there is good reason for believing that all of them exert their influence by participating in the reaction, in which case only the first section would survive. But this classification is as good as our present ignorance of the theory of catalytic action permits, and will require revision only after much further investigation has been made and many more results accumulated.

CHAPTER II.

SULPHURIC ACID MANUFACTURE.

As examples of the application of catalysis to industrial chemistry, the two methods for the manufacture of sulphuric acid deserve first mention—the Chamber process as an illustration of the first class of catalytic action, and the Contact process as illustrative of the second.

In each case the atmospheric oxidation of sulphur dioxide is the primary reaction involved. Now, at ordinary temperatures, and then only in solution, sulphur dioxide is oxidised with extreme slowness, while even at the temperatures which obtain during the roasting of pyrites, the reaction only takes place to a small extent. For accelerating the oxidation two separate methods are available, corresponding to the two processes above mentioned: the first based upon the capacity of oxides of nitrogen to serve as “carriers” of atmospheric oxygen to sulphur dioxide in the presence of water, and the second upon the property of platinum and other “contact” bodies to induce in the gaseous state the rapid formation of sulphuric anhydride. Each of these methods will be dealt with from the catalytic point of view.

I. CHAMBER PROCESS.

The oxides of nitrogen function as true catalysts for this process, since the greater part of them can be recovered unchanged from the products of the reaction and utilised repeatedly for accelerating the oxidation of further quantities of sulphur dioxide. Consequently, a modern Chamber plant includes

arrangements both for recovering the nitrogen oxides from the exit gases of the leaden chambers in which the oxidation of the sulphur dioxide has taken place and for reintroducing the same into the apparatus again.

The cycle of operations is briefly this: The hot gases from the pyrites burners, containing about 7% sulphur dioxide, are made to take up oxides of nitrogen by being brought into contact in a Glover tower with a solution of nitrosyl sulphuric acid, *i.e.*, sulphuric acid which has absorbed the nitrogen oxides of a previous operation. The gaseous mixture is then passed through a series of leaden chambers, into which steam is forced or dilute sulphuric acid sprayed, for the completion of the reaction and the deposition of the resulting acid. Incidentally, it should be noticed that about 15% of the total acid is produced in the Glover tower itself, the remainder in the chambers. After playing their catalytic rôle, the nitrous gases emerging from the last chamber are absorbed by sulphuric acid in a Gay-Lussac tower forming nitrous vitriol, which is transferred to the Glover tower for the introduction of its contained nitrous gases into fresh burner mixture.

In the most carefully conducted systems, however, a loss of nitrous fumes occurs, and this has to be made good, usually by the periodic addition of nitric acid at some point of the cycle. The English method is to introduce an iron pot containing nitre and sulphuric acid into the burner gas flue, whilst on the Continent it is the practice to add liquid nitric acid to the nitrous vitriol of the Glover tower. The nitric acid is employed as a convenient means for introducing the nitrous gases and does not itself function as the catalytic agent.

As to what is the real catalyst, many divergent opinions have been put forward. In a previous article (see *CHEMICAL WORLD*, 1912, I, 339), I have briefly outlined the more important theories, and it is not necessary therefore to reopen the discussion here. Many nitrogen complexes, apparently easily interchangeable, are formed by the interaction of nitrogen oxides, sulphuric acid, water and oxygen, and though, for the sake of convenience, nitric oxide may be referred to as the catalyst it is probably one of the above-mentioned bodies which really functions in this way. The various theories advanced by Lunge, Raschig, Divers and others, differ from each other chiefly in their conception of the intermediate compound or compounds.

There is no question, however, that the reaction proceeds in any other way than by means of “intermediate reactions.” These reactions have already been referred to in Chapter I., and in a later chapter a general discussion will be undertaken in the light of their bearing upon the explanation of catalytic action. At this stage it is only desirable to mention that the influence of a catalyst meets with some explanation if it can be shown that one or more intermediate compounds are transitorily produced, whose formation and decomposition proceeds more rapidly than the direct reaction. In the present case, taking a simple view of the

reactions involved, the instantaneous formation of "chamber crystals" from sulphur dioxide, nitrous vapours and oxygen provides a common lecture experiment, as also the equally instantaneous decomposition of these crystals when brought into contact with water. By the postulation, then, of the intermediate formation of "chamber crystals," the mystery surrounding the acceleration of the normally slow reaction between sulphur dioxide, water and oxygen by the agency of nitric oxide finds a plausible solution. Of course, the problem is not such a simple one as this; but an explanation even on these lines would be preferable to a curt dismissal of the reaction by simply dubbing it "catalytic"—a term too often employed to cover our ignorance. Only by a careful elucidation of the intermediate reactions involved can we justify our application of this term.

With regard to the above-mentioned inevitable loss of nitrous gases, recent investigation has demonstrated that the whole of the loss, averaging 3 to 4 parts of nitre per 100 parts of sulphur burnt as pyrites, cannot be accounted for by leakage, incomplete absorption, etc. In addition to these "mechanical" losses, there appears to be a decided "chemical" loss occasioned by secondary reactions, probably comprising the reduction of the active oxides of nitrogen to the inactive nitrous oxide, nitrogen, or even ammonia. The extent of the reduction, however, is still a matter of controversy.

The Chamber process is an old-established one, but with the aid of modern developments, such as Falding's high chambers and Opl towers, it is still able to compete successfully with the rival Contact method.

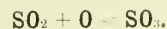
II. CONTACT PROCESS.

The catalytic activity of platinum in promoting the union of sulphur dioxide and oxygen was observed as long ago as 1831 by Phillips, but its successful utilisation upon an industrial basis is a matter only of comparatively recent years. The protracted development is accounted for by the many difficulties encountered, difficulties arising largely from the inadequacy of contemporary engineering chemistry. Now that these obstacles have been overcome, full technical success is assured and the process bids fair ultimately to oust the older Chamber process, at least in the manufacture of the more concentrated acid.

The most serious difficulties in the successful working of the process were concerned with the

regulation of the temperature and the gradual destruction of the catalytic power of the platinum.

The reaction—



is accompanied by the evolution of 32,200 calories, a quantity sufficient to damage irreparably the contact material unless precautions are taken. Of course, with the diluted burner gas mixture—and the law of mass action demands an excess of oxygen—the effect of the heat developed is not so great, though it is still enough to raise the temperature above that for obtaining the best results.

The influence of the temperature upon the reaction, together with other relations, was investigated by Knietsch, of the Badische Anilin u. Soda Fabrik, and his results in this connection, published in 1901, are indicated by Figs. 1 and 2. Technical burner gas, containing 7% sulphur dioxide, 10% oxygen, and the rest nitrogen, was passed at various rates over platinised asbestos

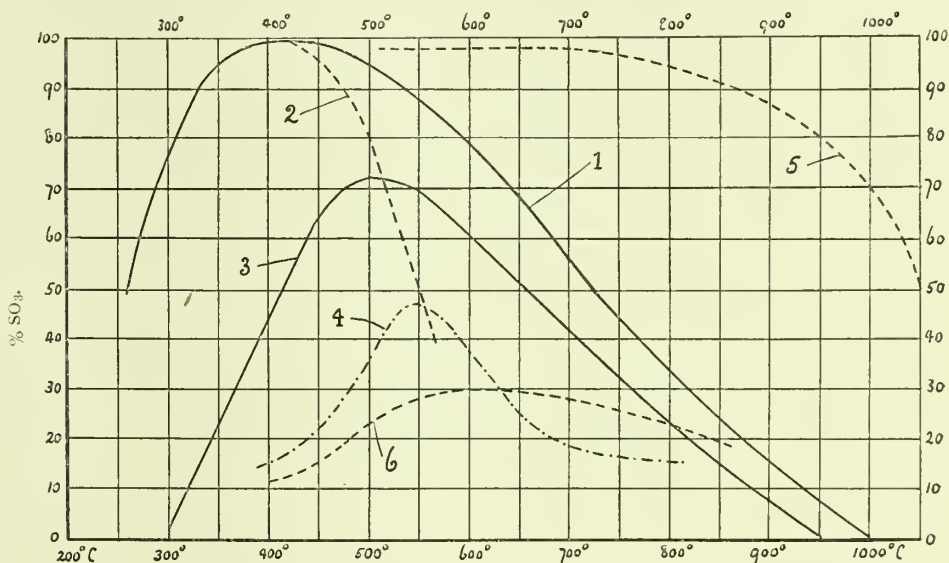


FIG. 1.—TEMPERATURE OF REACTION.

heated to different temperatures, and it was observed (see curve 1, Fig. 1) that the reaction began at about 200° C. and reached approximate completion at 420°, whilst above this temperature the yield of sulphuric anhydride gradually fell off until at 1000° no reaction was possible. By increasing the rate of flow, the temperature of maximum conversion increases, but at the same time, the maximum yield diminishes. This is clearly shown by curve 2, Fig. 1, which traces the loci of the maximum for the curves representing faster rates of flow. Curve 3, Fig. 1, is an example of such a curve, the speed in this case being 100 times as fast as that involved in curve 1.

In Fig. 2, the influence of the temperature upon the reaction is plotted against the rate of flow of the gases, or what amounts to the same thing, the quantity of platinum employed.

From these curves, it is evident that, with platinum as the catalytic agent, the most desirable

temperature lies at about 420°C . A higher temperature would increase the velocity of formation of sulphur trioxide, but at the same time detrimentally affect the equilibrium, so that a compromise is usually effected at, or somewhat above, 450° . The most suitable temperature depends, of course, upon several factors, such as the percentage of the constituents of the gas, the quantity passing through, the efficiency of the contact material, etc.

However, to maintain the contact mass at the desired temperature, some cooling is necessary, and this is generally brought about by causing the whole or part of the burner gases to pass through pipes surrounding the converter, whereby the entering gases are pre-heated to about 300° . Superheating at the beginning of the reaction is avoided, either by bringing the burner gases into contact with material of gradually increasing richness in platinum, or by effecting the reaction in separate stages in different converters, the sulphuric anhydride contained in the gases leaving the first converter being absorbed before passing the gases into the second.

The remaining difficulty, that of the gradual diminution in the efficacy of the platinum employed, is one which has troubled manufacturers from the very beginning. As before, the cause of the diminution was located by the researches of the Badische firm, and found to reside in the accumulation in the contact material of "poisonous" substances arising from the impurities contained in the burner gases. In Chapter I. it was mentioned

suspended impurities, chief among which are compounds of arsenic, antimony, phosphorus, selenium, mercury, and lead. The presence of a trace of water, however, was found to be essential to the reaction, though in greater quantities water had a deleterious effect.

To remove objection on this ground to the use of platinum as contact material, the burner gases are subjected to purification before being introduced into the converter. This is a simple matter as regards the greater quantity of impurities present in the gases, but unfortunately the last traces are found to resist removal very tenaciously. In a modern plant, purification is effected by first treating the gases leaving the burners with a jet of steam, then by cooling and washing, and finally by passage through sulphuric acid to remove all water but that sufficient to promulgate the reaction. Optical and chemical examination should then indicate complete absence of impurity. It has been suggested, as an alternative, to first condense or compress the burner gases and then allow them to expand in the presence of porous material, when the impurities are stated to remain behind.

Owing to the cost of purification, as well as to the high price of platinum, the use of other contact material is now finding application. Ferric oxide appears to be the most promising of these, for, apart from its cheapness, which permits of repeated replacement, its activity is not liable to the same degree of diminution as platinum. Arsenic compounds, for instance, combine with it to form a non-

volatile compound which only slowly reduces the activity. Moisture appears to have the most deleterious effect, and the burner gases are therefore just dried before being introduced into the converter. It might be noticed that arsenic pentoxide, free from iron, itself possesses good catalytic powers for this reaction.

The great disadvantage of ferric oxide lies in the fact that quantitative conversion of sulphur dioxide into sulphuric anhydride cannot be obtained by its aid. This is brought out by curve 4, Fig. 1, which represents the yields obtainable at various temperatures when pyrites cinders were employed as contact agent. From this curve, it will be seen that

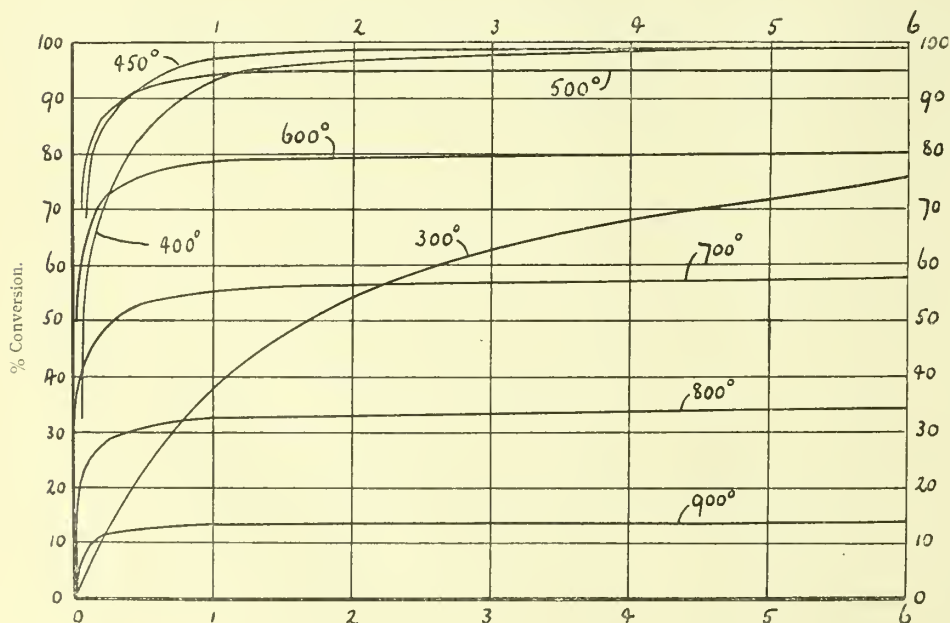


FIG. 2.—QUANTITY OF PLATINUM OR TIME OF CONTACT.

that mere traces of these "poisons" act detrimentally to the activity of the catalyst, and contact platinum is a case in point, for the presence of 1 to 2% of arsenic compounds was found to render it completely inactive. In addition to moisture, crude burner gases contain both gaseous and

the maximum conversion does not quite attain 50% (under modern conditions the yield does not rise much above 60%), and then at a temperature over a hundred degrees higher than is requisite for platinum as contact material. The fact that the optimum temperature for ferric oxide is higher

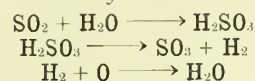
than for platinum is really no disadvantage, because at the higher temperature the reaction velocity is far greater, and this allows of a more rapid production of sulphur trioxide. Ferric oxide, therefore, finds its proper sphere of usefulness when employed in conjunction with platinum, the former being used for the first stage of the operation at high temperatures and, after absorption of the resulting sulphur trioxide, employing the latter to complete the reaction at a lower temperature.

Incidentally, attention is drawn to curve 5, Fig. 1, which shows the effect of heat upon sulphuric anhydride in an empty porcelain tube, *i.e.*, out of contact with the catalytic material. The remarkable deduction can be drawn from it that sulphuric anhydride, once formed, is very stable at quite high temperatures when contact substances are absent. Complete dissociation is only obtained at 1200° C. Curve 6 summarises the results when pieces of porcelain were employed as the contact material.

Investigators have been busy, in recent years, seeking still other catalysts for the Contact process, and with considerable success. Thus, besides ferric oxide, vanadic and tungstic oxides are found to be available, as also the sulphates of nickel and cobalt. In addition, the oxides and sulphates of chromium, manganese, uranium and copper; the oxides of aluminium, zinc, and particularly of the rare metals; natural and artificial porous material, usually incorporating finely-divided platinum; are numbered amongst the list of catalysts, and of late years, many patents have been taken out pertaining to these. Indeed, the discovery of a catalyst of some sort appears to be an easy matter. So far as is known, however—and most factories maintain great secrecy upon this and similar points—platinum in the form of platinised asbestos, and ferric oxide as pyrites cinders, the former the material first to be employed and the latter introduced but a few years later, remain the only catalysts in practical use.

With regard to the theory of this reaction, but little can be said. Platinum is usually regarded as belonging to the second class of catalyst, *viz.*, those which exert their influence by reason of the occlusion, or condensation upon their surface, of the reacting gases. Some doubt, however, as to the correctness of this belief is raised by a consideration of the numerous other catalysts above referred to, for many are seen to be oxides or sulphates of metals of dual valency whose action depends upon the reduction of the higher form of oxidation at the same time as the lower is oxidised. Ferric oxide, of course, certainly belongs to this class. Moreover, an hypothetical platinum dioxide (Engler and Wöhler) has for some time been regarded by a few as the transitory intermediate product, whilst the ordinary monoxide is also said to possess strong oxidising powers (Wöhler). The majority of chemists, nevertheless, arguing from the well-authenticated influence of the fineness of division of a substance upon the acceleration of a reaction, prefer to regard the action of platinum, at least, as being more physical than chemical. In any case, further research on this point is needed.

Quite recently (1912), a new theory of the catalytic action of platinum in this reaction has been put forward by Wieland. It has been mentioned that the absolutely dry mixture refuses to combine under the influence of platinum, and on this fact Wieland bases his hypothesis. The platinum, in opposition to the ordinary assumption, does not then cause the combination of sulphur dioxide and oxygen, but simply promotes the combination of oxygen with hydrogen which is liberated during the reaction, the resulting water being then reintroduced into the cycle. The equations—



then represent the stages of the reaction.

(To be continued.)

PERSONAL AND OTHER NOTES.

THE Paris Academy of Science proposes to select the following subjects in their chemical section for the following prizes during 1915: the Jecker prize of 10,000 francs, for investigation connected with the progress of organic chemistry; the Cabours prize of 3,000 francs, for the encouragement of the work of young chemists. The Montyon prize of 2,500 francs goes in connection with work connected with unhealthy trades, and the Houzeau prize of 700 francs for the work of a young chemist. They will also award the Lavoisier medal for work in chemistry; also the Berthelot medal, which goes to a chemist who takes prizes in the above award.

Mr. F. G. Pope, an external student of the East London College, has had conferred upon him the degree of Doctor of Science in Chemistry of the London University.

Dr. E. J. Russell is giving a course of eight lectures at the Royal College of Science on "Recent Advances in Soil Fertility." Admission is free.

Dr. R. Willstätter (Berlin University) will lecture at University College during May on his well-known work in connection with plant pigments. Prof. P. Sabatier will lecture on catalysis and catalytic reactions.

Dr. Harden, F.R.S., will lecture at King's College during February on carbohydrate fermentation (four lectures).

Nature reports that during the last year the Columbia University of New York received in gifts £284,000 in all. In spite of this an appeal for further funds is made. The teaching staff numbers 848, as compared with 781 in 1912. The number of students was 9,379, which, we think, equals that of the Berlin University.

It is with deep regret that we notice the death of Professor Popperwell Bloxam, who was so well known in connection with his work in India on the preparation of Indigo. This work was continued on his return to this country at the Leeds University. It is not so long ago that he called at the office of this journal, urging that notice might be given to the possibility of resuscitating this industry in India.

NOTES ON CHEMICAL ENGINEERING.

By J. W. HINCHLEY, A.R.S.M., WH.Sc.

CHAPTER VI. (continued).

Scraper Conveyors.—A typical scraper conveyor consists of a trough along which the material is pushed by means of scrapers attached to an endless chain. At each end of the chain a terminal pulley is provided to drive or guide the chain, and guiding strips are fixed at the sides or in the middle of the trough over which bars or rollers pass to maintain the scrapers out of contact with the bottom and sides of the trough. Scraper conveyors, like worm conveyors, are unsuitable for hard and gritty

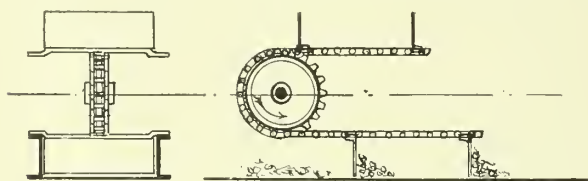


FIG. 63.—Scraper Conveyor.

materials. A simple form is shown in Fig. 63, from which the arrangement of driving chain and guide plates is readily seen.

In some designs a central guide is used, in others the links of the chain form the scrapers, and again in others the sides of the trough are rendered unnecessary by the provision of sides to the scrapers.

A variety of scraper conveyor which is very useful in chemical factories, especially where sludge is transported in channels of too small an inclination to prevent settlement, consists of a rope carrying discs or pistons of metal or wood which push the material along the V or U-shaped trough.

The speed of scraper conveyors varies from 50 to 150 ft. per minute, and the power required is readily estimated by means of the formula—

$$\text{H.P.} = \frac{W.L.\mu + b.w.s.}{33,000 A}$$

where W is the weight of material transported per

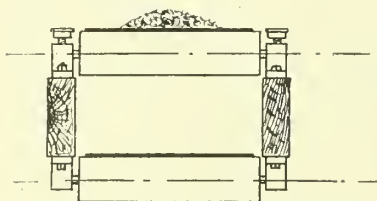


FIG. 64.—Band Conveyor.

minute, L is the length of the conveyor, μ is the coefficient of internal friction of the material, A is a factor (usually about .8), b is a frictional factor (.01),

w is the weight of the chain and scrapers, and s is the speed of the scrapers in feet per minute.

Band Conveyors.—Band conveyors consist of endless belts to carry the material to be transported, which run over terminal pulleys and are supported at intervals by guide pulleys.

Although the band conveyor in its original form was only suitable for light materials, it is now largely used for heavy materials as well.

There are three types of band conveyor: (1) light band conveyors in which the band remains with a flat surface; (2) heavy band conveyors in which the

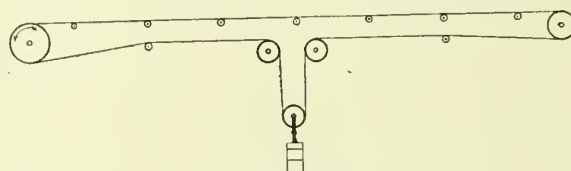


FIG. 65.—Weighted Pulley Belt.

band when carrying the material is kept hollowed by suitable guide pulleys; (3) metal band conveyors.

The bands of light band conveyors are made of cotton or other cloth covered or treated with rubber, guttapercha or balata. The supporting or guide rollers are generally about 6 ins. diameter, and are spaced at distances of 6 ft. on the loaded and at 12 ft. on the slack or unloaded side. The bearings of these rollers are generally carried by a pair of

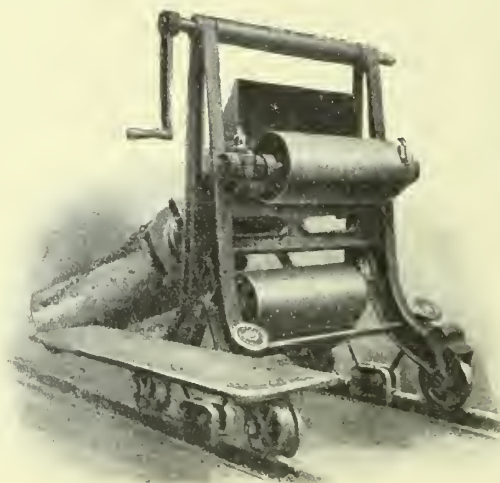


FIG. 66 —Belt with "throw-off."

steel or timber joists, as shown in Fig. 64. When delivery takes place at a fixed position a simple screw adjustment for tightening the belt is sufficient,

but in other cases a weighted pulley round which the empty side of the belt passes, is necessary to give the requisite tension (Fig. 65).

The driving pulley should always be placed to make the loaded side the tight side of the belt.

The material may be discharged from the belt at the driving pulley, but for discharge at an intermediate point a throw-off carriage is required (Fig. 66). The band rises to the upper pulley of this carriage and changes its direction suddenly by passing round the lower pulley, while the material by its inertia travels forward and falls into the hopper shown and through the shoot at the side.

The material must be delivered on to the middle half of the band at a horizontal velocity approaching that of the band. This is readily accomplished by the use of a shoot inclined at an angle of from 40 to 45 degs. When working such bands at their full capacity a pair of inclined rollers are sometimes provided to hollow the band at the point of charging, and sometimes such rollers are fitted at intervals when spreading of the material is feared.

The speed of band conveyors for grain and light material varies from 400 to 600 ft. per minute, and the capacity of bands of over 9 ins. width is given in tons per hour when running at 500 ft. per minute by the formula—

$$C = \left(\frac{b}{2} - 2\right)^2$$

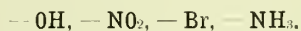
where b is the width of the band in inches.

(To be continued.)

NOTES ON RECENT THEORY AND PRACTICE.

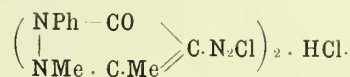
BY HERBERT H. HODGSON, M.A., B.Sc., Ph.D.

HEMMELMAYR (*Monatsh.*, 1913, 34, 365—388) investigates the relative stability of the carboxyl group in the various substituted benzoic acids, by boiling them in aqueous or aniline solution, and estimating the rate of decomposition. The following four substituents are arranged in descending order as regards their effect on the stability of the carboxyl group:

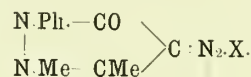


The orientation of the amino group with respect to cyclic nitrogen is important, being supported by the work of Mills and Watson on the amino-quinolines where 3-amino-quinoline is readily diazotisable while 2- and 4- have not yielded diazonium salts. Knorr has proved certain bases of the pyrazole series to give rise to stable diazo salts, which like the aromatic analogues couple with β -naphthol, etc., although, except in the case of Forster and Müller's triazo-antipyrine, they have not been of success in syntheses involving the replacement of the diazo-group by other radicles. By diazotising 4-amino

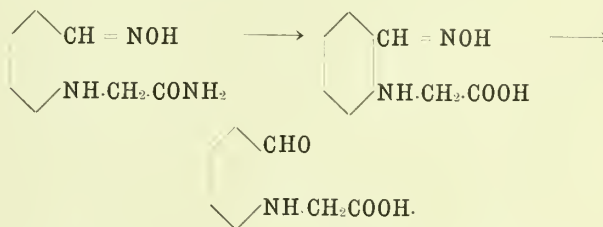
1-phenyl-2:3-dimethyl pyrazolone (4-amino-antipyrine), the authors have isolated 1-phenyl-2:3-dimethylpyrazolone-4-diazonium chloride which was obtained as a crystalline hygroscopic salt of constitution—



The additional molecule of HCl is probably attracted to the complex by the basic nitrogen atoms of the pyrazolone rings. The existence of these normally constituted diazonium salts containing the pyrazolone ring is of interest in connection with current theories regarding the structure of diazo-compounds, inasmuch as it justifies the contention that co-ordination between the diazonium complex and the unsaturated ring may involve a contiguous carbon atom as well as one in the para-position. Cain's para-hemiquinonoid formula is inapplicable to these pyrazolone diazonium salts, which may be represented as due to a rearrangement among the principal valencies thus:—



In spite of the importance of phenylglycine—*o*-carboxylic acid in technical chemistry, the corresponding *o*-aldehydophenylglycine appears to have been overlooked, and as it seemed an apparent excellent source for the preparation of indole and its derivatives, Gluud (*J. C. S.*, June, 1913) essayed its isolation. The direct interaction of *o*-amino-benzaldehyde and chloroacetic acid or ester did not give good results, still less if the oxime was used instead of the aldehyde. A much better method was found in the decomposition of the oxime with chloroacetamide in the presence of calcium carbonate, the oxime being prepared from *o*-nitrobenzaldehyde by reducing the oxime with ammonium sulphide according to Gabriel and Meyer's method. On boiling the above oxime with alkali that of *o*-aldehydophenylglycine was obtained, and the amide of the latter on careful treatment with dilute sulphuric acid afforded the desired result.



Two interesting patents for the preparation of intermediate dyestuff compounds are to be found in the tinctorial literature. Meister, Lucius and Brüning (D.R.—P. 256623) obtain a 94–96% yield of anthraquinone when an intimate mixture of anthracene, glass, wool or asbestos powder, and a metal or metallic oxide (such as zinc dust or lead oxide) is

carefully treated with nitric acid fumes at 75—100° C. for about 9 hours. On slowly raising the temperature to 280° C. the anthraquinone sublimes in long, yellow needles. The Bayer Co. (D.R.—P. 255724) prepare the sulphonic acids of the benzene and naphthalene series by passing an electric current through an alkaline solution of an aniline, naphthylamine or naphthol polysulphonic acid in the presence of sodium amalgam, when a sulphonic acid group is eliminated, *e.g.*, aniline 3 : 6 disulphonic acid becomes aniline — 3 — sulphonic acid, and α -naphthylamine becomes α -naphthylamine 3 : 7— disulphonic acid.

In the July number of the *J. C. S.*, Morgan and Pickard publish a study of the influence of substitution on the reactivity of *p*-phenylenediamine, and find that the introduction of a negative radicle into the aromatic nucleus of *p*-phenylenediamine very considerably inhibits the acetylation of the amino group contiguous to this substituent. The picrylation of this amino group is completely prevented, while the introduction of one nitro group into the *p*-phenylenediamine or 2 : 5 tolylene diamine nucleus diminishes very considerably the diazotisability of the contiguous amino group. The presence of two chlorine atoms in ortho position with respect to one amino group of *p*-phenylenediamine, inhibits completely the diazotisation of this group.

An interesting investigation has been carried out by Yoshito Yamachi (*Amer. Chem. Journal*, 99, No. 1.) on the reaction between ozone and certain inorganic salts. Since ozone has come rapidly to the front during recent years, and now is a product of increasing commercial importance, *e.g.*, for the sterilisation of water, its reactions are receiving more and more attention by chemists. Yamachi remarks that while several previous workers, such as Schönbein, Williamson and Maquenne, have studied the oxidation of certain inorganic salts by ozone, only the final products of the reaction have, as a rule, been described, and not the way in which the ozone has acted to bring them into existence. Since the concentration of ozone differs with every preparation, all methods of determining the concentration through the consumption of the gas must involve using up the preparation, *i.e.*, when the concentration is known the preparation no longer exists. The method of direct weighing is also inconvenient, and the author has contrived a new method of dividing one sample into two parts, and of determining the concentration of the one by measuring that of the other by analysis. So far as the author could determine, ozone seems to be decomposed according to the equation $O_3 = 3O$ only in the case of the oxidation of stannous chloride. The decomposition, however, usually proceeds as $O_3 = O_2 + O$. The action of ozone on sodium thiosulphate has been studied, perhaps for the first time, and two reactions appear to occur in which the ozone seems to bring about the catalytic decomposition of the thiosulphate and then partially oxidises the sulphite formed. Thallic oxide is rapidly and completely formed by ozone from a thalious salt and in the author's opinion may be

utilised as a gravimetric method for the quantitative determination of ozone.

The change of colour of metallic haloid solutions receives attention from Garrett in the July number of the *J. C. S.* On varying the concentration, temperature, or solvent, as well as on the addition of colourless haloid salts considerable colour alterations take place. The phenomenon is probably bound up with that of variable valency of the parent metal. Garrett opines that the changes may be due to the formation of two types of complex radicles, *viz.*, acidic and metallic, and by quantitative spectrophotometric measurements he has distinguished these types. Copper haloids, for example, form acidic complexes, whilst chromium haloids give metallic complexes; the solvent, however, must be assumed to take some part in the change. Selective absorption bands due to the complexes were found by photographing very thin layers of saturated aqueous solutions of copper bromide and chloride and of nickel bromide. In the typical cases of copper and chromium haloid solutions it was demonstrated that the various parts of the absorption spectra may be attributed to various entities in the molecules of the salts.

Like ozone, the use of ultra-violet light is ever playing a part of increasing importance in chemical investigation. The latest discovery is that of Bornstein who, in trying to apply the studies of Henri on the depolymerising action of ultra-violet rays on rubber succeeded in vulcanising the latter. Industrially, sulphur and other ingredients are mixed with rubber, and, by means of a final heating in an autoclave, combination is effected in such a way that the rubber is henceforward rendered capable of resisting variations of temperature. Now, in preparing very fine pellicles with virgin rubber and a little sulphur, it suffices merely to enlighten the mixture with ultra-violet radiations in order to fix the sulphur, *i.e.*, to bring about vulcanisation.

CORRESPONDENCE.

The Fundamental Weakness of the Science College.

2nd January, 1914.

SIR,—It is the experience of the technical chemist that one learns more in the first six months in "works" than in the whole of the four or five years spent at college. Hence, there arises in the mind of the chemist a certain dissatisfaction with the institution that trained him but has failed to turn him out more fitted to face industrial conditions.

It is generally conceded that there is some justification for this dissatisfaction, and suggestions for the reform of college education are as common as blackberries in autumn. I believe that the real cause of the present unsatisfactory state of scientific education is nearly always overlooked. The success or failure of any system of education depends, first and last, upon the teacher, and it is the teaching staff in the college which constitutes its main weakness.

There is, first, the professor, a man who has won distinction, not in the field of education, but in that of research. Then come lecturers and assistant lecturers, demonstrators and junior demonstrators, but only in the rarest instances does any one of them regard education as the main work of his life. They have accepted posts on the teaching staff because the short hours and long vacations enable them to devote their energies to work which they consider of first importance. The thoughts of the eminent professor are centred on his research. The head lecturer aims at attaining the eminence of the professor. The junior demonstrator is occupied in accumulating as many letters after his name as the head lecturer. The educational work of the college, in so far as it interferes with these ends, is tolerated only because it brings a sufficient means of support while they are occupied with the only work which, in their eyes, really matters.

The technical chemist, looking back upon his college career, is apt to feel aggrieved with the teaching staff; but in laying the blame upon them he is far from justified. No one can deny that the main energies of the professor should be directed towards research. The lecturers, in their efforts to emulate the professor, are also adding to the world's knowledge; and it may be argued that the accumulation of a tail by the junior demonstrator not only adds to his brilliance, but may increase the general well-being of mankind. It is altogether right and proper that these persons should be engaged in research, but it is altogether wrong that they should look upon the training of others as an unimportant adjunct to that of research.

It is urged that working in an atmosphere of research provides the finest possible training for the young student. A good defence can be made for this theory; but in practice it does not work out quite as well as its advocates suggest. On entering a college his attitude towards research is one of respect, even of awe, but commonly enough, before he has reached the end of his second year, his ideas have altered. I open a volume of the *Journal of the Chemical Society*, and glancing through the abstracts conclude that the student of twenty or thereabouts, who can feel any enthusiasm for the major part of such work, must be an exceptional youth. No one can deny that very much of what passes for "research" at the present day, is of a highly mechanical nature. A born researcher is a genius, and these are not nearly as plentiful as college demonstrators, a fact which the student is usually clear sighted enough to realise. He soon finds that a large proportion of academic research work is carried out, not as a guarantee of good faith, but with a view to publication, and is prompted by a determination to obtain a degree, or some other distinction.

It is, therefore, open to doubt how far the true research spirit, which is of such importance to industry, can flourish in such an atmosphere. Certainly the college research laboratory is very different from that of a works research laboratory. In the college no one feels that it is of overwhelming importance whether Smith does or does not succeed in adding another group to some already overburdened ring. Even if he does not he can publish a paper about his failure. But in the works success alone counts; and, as a rule, this must be speedy. Problems are clamouring for solution. Failure to solve them may mean financial loss to the firm for whom the chemist is working; success may possibly lead to the creation of a new industry. Almost always big issues are at stake, and the work demands pertinacity, resourcefulness and breadth of knowledge altogether unnecessary for half the academic

research, with the reports of which our scientific journals are filled.

If it is still maintained that the student should be surrounded by those who are working along original lines, it by no means follows that the research worker must also be the teacher. If the born researcher is a rarity, so is the born teacher; and it is seldom that one man can possess both qualifications. Even when he does, it is almost inevitable that he will neglect one for the sake of the other. The researcher should be freed from the burden of teaching and the teacher should make the education of others his only work.

If science is to be taught as it ought to be taught, the teacher must receive a salary as high as, and possibly higher than, is paid for any other class of professional work, and here we come to the root of the whole difficulty. The real blame for the state of things must be laid upon a short-sighted public, which still considers that any salary is large enough for a teacher, and refuses to recognise that the training of the rising generation is the most important and difficult work in the world, and will never be done efficiently until salaries are offered which will induce men of rare ability to continue work in the teaching profession.

The last thing demanded of a candidate for a post on a college staff is evidence of his ability to teach. Indeed, it would be futile to make this demand, because a man who possessed such qualifications would never apply for the post of teacher; he can make so much more money elsewhere. Consider the qualities which go to make a good lecturer. He must be something of an orator; possess personal magnetism, a gift for speech and a capacity for lucid expression. He must be endowed with enthusiasm for his subject and a desire to educate others. Now, a man who possesses personal magnetism, a gift for speech, a capacity for lucid expression, and inexhaustible enthusiasm, is so valuable a product that he can earn thousands in the commercial world where he would earn hundreds as a teacher. The results are familiar to anyone who has passed through a college training. The badness of pulpit oratory is not for one moment to be compared with the badness of lecture-table oratory.

There is a story told of one of England's greatest scientists who was temporarily called away from his college to London. In his place, as lecturer, he left a young assistant named Day. To the students' joy, the young assistant proved to be an able and lucid lecturer. Then came the news that the great scientist had been knighted and was returning, whereupon a student wrote upon the blackboard: "Work while it is yet Day, for the knight cometh when no man can work." There are few college students, past or present, who cannot appreciate this witticism. Of how many of our lecturers in our colleges to-day could it be said that, with them as teachers, no man can work?

Yet no one seems to worry. Thousands are spent upon increasingly elaborate colleges. Our laboratories are so fully equipped that the student can do almost anything except think, by touching a button, or turning on a tap. But the fact has been overlooked that more can be learnt from a good teacher in a back kitchen than from a bad teacher in the most magnificent structure that has ever been erected.

Yours faithfully,
LEONARD WICKENDEN, A.C.G.I.

Flushing, U.S.A.

ENGINEERING NOTES.

BY R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

Inappropriate Terms.

It is a pity the nomenclature of alloys is so large a subject in itself, otherwise the Institute of Metals would have open to its hand another field in the misapplied terms used to describe conditions, machining qualities and other states, chemical and physical, of the alloys with which they are concerned.

Undoubtedly a great simplification could be made nowadays in the engineering trade generally, if some standard was arrived at for words which should correctly describe and be more generally used for a lot of often met conditions in well-known products.

To take a case in point: good soft copper is a nasty metal to machine owing to its "draggy" nature. The better the copper and the softer its condition by annealing or otherwise, the worse does this trouble become, owing, doubtless, to the fact that copper of the nature indicated has an elongation in the neighbourhood of 70 or 80%.

Brasses high in copper suffer in a slightly modified degree from the same defect, and the only easy way of remedying it is to introduce comparatively large percentages of certain well-known impurities (well-known in this connection, we mean).

Unfortunately, these additions injure the metal for certain uses for very obvious reasons.

The breaking strain may be and frequently is increased, sometimes greatly increased, so usually is the yield point, but the elongation, the source of "draggy" cutting in, say, an automatic lathe, goes down to an undesirable extent, and in the case of Government work the affinity of picric acid for various metals and its tendency to form unstable compounds owing to their presence renders them utterly impermissible. Now comes the point:

The easiest, if not the cheapest, way out of the difficulty is to supply a very pure brass for all those numerous purposes for which, say, a Government contractor uses it, and manufactures it into its finished state by means of edged tools. The pure brass will probably answer the Government specification more than sufficiently well from a chemical and physical point of view, but owing to its "draggy" machining qualities be rejected by the contractor or the sub-contractor and on very astonishing grounds, to wit, because it is "too hard."

This is the frequent, nay, almost invariable, misdescription applied to a high copper brass, which will not machine for the reasons given. If the brass producers are not, and they very frequently are not, engineers, the article will then be slightly annealed and returned (it is to be noticed that it has passed and will again quite rightly pass Government inspection), whereupon, as far as the engineering contractors are concerned, the last state of that alloy will be worse, indeed, much worse, than the first, leaving many puzzled.

The misnomer "too hard" has, of course, crept in from iron and steel practice, which in modern times has a greater vogue and older standing in the matter of its machining properties.

Most steel which is "too hard" to machine is so from that very reason, *i.e.*, because it ranks high in the technical hardness scale, whether it also be tough and draggy or not.

The foregoing is simply one of the many instances of the very misleading descriptions which are applied almost daily to articles in general use.

Electric Purifying Furnace.

The American journal, the *Brass World* for September last, describes shortly, with a diagram, a new type of electric furnace, patented by Ezekiel Weintraub of the General Electric Company.

Its purifying uses are limited by the fact, that it is only suitable for application in the case of materials which mercury will neither alloy with nor contaminate, but against this must be reckoned its great advantages over previous forms for certain classes of refractory materials, which can be treated unbound or in a dusty form.

The contrivance is as follows:

A reservoir (usually cathode connected) of mercury discharges through a quartz or other non-conducting pipe across a bell jar containing nitrogen or other protective gas into another reservoir, from which it is afterwards returned to the first.

The bell jar is sealed with mercury or otherwise on to a soapstone or other non-conducting base, mounted in the centre of which, and inside the bell jar, is a water-cooled cupel-shaped anode, in which the boron, silicon, tungsten or carbide suitable for treatment by this method is contained; this is made the anode. The stream of mercury passes within arcing distance above this cupel, in which the boron or other oxides may be very highly heated and dissociated by the use of a very high tension arc, for as will be seen from the above the cathode is self-cooling, and the temperature of the anode can easily be kept decently low.

The device is a reasonably simple one, and the fact that it can be used with materials suited to it when those materials are in a dry and powdered form is a great advantage; further, there is nothing that under ordinary conditions can get out of order. These points should make the device of great utility within its own well-defined limits.

Horsepower Calculators.

All those who have at one time or another had to indicate ordinary reciprocating steam engines must have noticed two or three inconveniences associated with this simple operation in ordinary practice. Diagrams are apt to get smudged, torn or mislaid. A single line diagram only gives the horse-power developed in the cylinder in one stroke in one direction, on the other hand, for a load constantly varying, such as that of a metal-rolling mill or that of a series of filling and emptying chemical mixers, a series of superimposed diagrams give what can only be characterised as a mush, and this even with an old-fashioned and fairly slow moving engine. A mean result simply cannot be obtained from this.

The Böttcher indicator which has lately come on the market obviates this by a device consisting essentially of an integrating planimeter actuating a counter of the ordinary odometer type. The integrating device gives mean pressures which are registered and added by the counter for any given number of strokes, and this multiplied by the engine constants in the ordinary P.L.A.N. formula at once gives the horse power (mean) for any given number of strokes of the engine.

This does away with far more than half the time and trouble spent by the average competent fitter in indicating an engine, for they are usually very slow in working out the diagram.

REVIEWS OF BOOKS.

"A DICTIONARY OF APPLIED CHEMISTRY." By Sir Edward Thorpe. Vol. V. Sodium—Z. LONGMANS, GREEN & Co., London, 1913. Revised and Enlarged. Pages 830 + viii. Numerous Illustrations. Price 45/- net.

This volume completes a work, for which by a consensus of opinion, there is nothing but praise. The more it is referred to, the higher one's opinion is concerning its utility as a first aid to a new subject, and a convenient book of reference to many an old one. Its information is thoroughly up-to-date; and what is of more importance, the different contributors have, under the guiding hand of the editor, included just the kind of information that a practising chemist requires.

It would be almost invidious to single out certain articles in this volume for special praise, but mention may be made generally to those dealing with sugar, sulphuric acid, the vegeto-alkaloids, water, and the destructive distillation of wood, as being particularly interesting.

We once more offer our congratulations to the editor on the successful conclusion of an arduous work, and to the general chemist on having such a reliable and useful work at his command.

"CHEMICAL TECHNOLOGY AND ANALYSIS OF OILS, FATS, AND WAXES." By the late J. Lewkowitsch. Fifth Edition, entirely Rewritten and Enlarged. Vol. I. MACMILLAN & Co., LTD., London, 1913. Pages 668 + xxii. Chapters XII., with Illustrations and numerous Tables. Price 25/- net.

It is with a feeling of melancholy, that we turn to this edition of a well-known text book, which represents its author's last word to chemists in general. It comes from one who worthily represented chemistry on its industrial side.

Its message is obvious; it is a call to others engaged in the different sections of industrial chemistry to equal thoroughness and attention to detail.

To those chemists directly interested in the subject, this work represents a careful record of practically all the published work done in this direction which calls for the attention of the chemist.

The author had the distinct advantage of a personal knowledge of many of the difficulties which beset the chemist in industrial work. He had also the faculty of appreciating recent developments in their true sense and gauging their industrial significance.

It is almost superfluous to recommend this work, for it is known to all for what it is, through its previous editions. The rapid increase in the literature connected with this subject has made it

necessary to publish this work in two volumes, the second of which was happily in the press at the time of the death of this talented investigator.

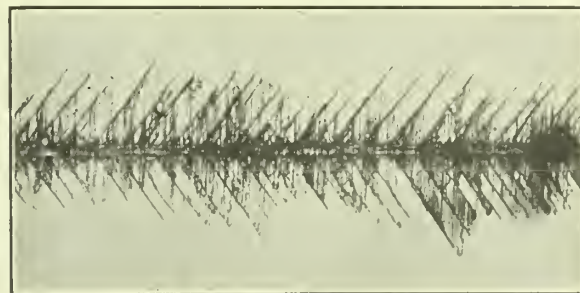
"THE MICROSCOPIC ANALYSIS OF METALS." By Floris Osmond. Second Edition. CHARLES GRIFFIN & Co., LTD., London, 1913. Pages 313 + xi, with Appendices and Index. Divided into III. Parts, with 192 Illustrations, Price 8/6 net.

Of all the books which have dealt with this subject in its many aspects, surely this one, in its English guise, remains supreme. It is so much more than a mere text book. It gives the general reader a clear insight into the subject dealt with. It attempts to explain as well as demonstrate, and this is specially seen in the illustrations which have been selected to accompany the text.



NEEDLE SCRATCH ON ANTIMONY ($\times 400$).

There is magic in a work of this nature which the student will be the first to realise, and in this book, which is the second edition, an insight into the ways of a real experimenter may be obtained, which will last long after the book has been returned to its place on the bookshelf.



NEEDLE SCRATCH ON CALCITE ($\times 400$).

The method of attack is well exemplified in the accompanying illustrations reproduced from the

work itself. A word may be said in praise of the way it has been translated.

"COAL TAR DISTILLATION AND WORKING UP OF TAR PRODUCTS." By **A. R. Warnes.** JOHN ALLAN & Co., London, 1913. Pages 185 + xii, with Appendix and Index. Chapters XVIII., with 65 Illustrations. Price 7/6 net.

This work presents, in a readable way, a first-hand account of the many operations involved in the distillation of coal tar and the plant utilised in the many operations connected with the same.

It is divided into some eighteen chapters, all of which are interesting, and the many illustrations are particularly free from reference to special manufacturers; they are not of the order of those found in trade catalogues (reproduced by permission). The book is thoroughly interesting, and bears the stamp of practical experience on its pages. It will, therefore, be appreciated by those engaged in this industry.

"THEORETISCHE CHEMIE VOM STANDPUNKTE DER AVOGADROSCHEN REGEL UND DER THERMODYNAMIK." By **Walther Nernst.** Seventh Edition, FERDINAND ENKE, Stuttgart, 1913. Pages 828 + xvi, with Index. Divided into IV. Parts. Chapters XXXIII., and 58 Illustrations. Price M.22.

The seventh edition of this standard work naturally contains a good deal of new matter. It is divided into four chief sections, which deal in an exhaustive and characteristic manner with modern physical chemistry from the author's particular standpoint. It is impossible to do justice to this work in the space at our disposal, but particular attention may be drawn to the chapters dealing with the ultimate size of the molecule, and the sections dealing generally with the atomic and molecular state. Thermochemistry is naturally dealt with at length and electrochemistry and photochemistry are also considered.

The work in its previous editions is, of course, known to every chemist, and it only remains to record that this last edition fully maintains the standard set in the previous ones, and will be welcomed by those interested in this side of chemistry.

"GRUNDRISSE DER KRISTALLOGRAPHIE." By **Gottlob Linck.** Third Edition. GUSTAV FISCHER, Jena, 1913. Pages 272 + v, with Index. IV. Parts with XV. Chapters, including 631 Illustrations and 3 Tables. Price M.11.50.

The third edition of this work once more draws attention to the special interest of this subject to the chemical student. It is almost impossible to imagine that so abstruse a subject could be more satisfactorily dealt with than in the present volume.

The illustrations, some 630 in number, which accompany the text aid the author in presenting his subject in a thoroughly satisfactory manner, and make this work of such interest to the student.

As an introduction to this subject, with which nearly all chemists have necessarily some interest,

it will be gathered that this work holds an almost unique position.

The subject is one of increasing importance from the fact that under its more recent developments (which are not dealt with in this volume, as they have been published since its production) the chemist and physicist can meet on common ground.

We have nothing but praise for this volume, and recommend every student, who reads German, to see that it is one of the works found on his bookshelf.

"INTRODUCTION TO THE RARER ELEMENTS." By **Philip E. Browning.** CHAPMAN & HALL, LTD., London, 1912. Pages 232 + vii, including Index. Chapters XIV., with a Frontispiece. Price 6/6 net.

The third edition of this well-known work calls for but few remarks. It was originally written in connection with a short lecture course at the Yale University, and may be regarded as a thoroughly sound compilation, and gives a satisfactory insight into the work already done in this direction.

The subject-matter is arranged in a handy form for reference, especially for those who wish to follow up work in this direction.

BOOKS, ETC., RECEIVED.

"Allen's Commercial Organic Analysis," Vol. VIII. Enzymes, Proteins, Albuminoid Substances, Milk and Milk Products, Hæmoglobin and Blood, Proteoids, Fibroids. Edited by W. A. Davis and S. S. Sadtler. *Contributors:* E. F. Armstrong, S. B. Schryver, L. L. van Slyke, H. Leffmann, C. Revis, W. D. Richardson, J. A. Gardner, E. R. Bolton, G. A. Buckmaster, W. P. Dreaper, and J. Alexander. Fourth edition. J. & A. Churchill, London, 1914. Pages 687 + x, with Appendix and Index. Price 21/- net.

"A Treatise on Chemistry," by H. E. Roscoe and C. Schorlemmer. Vol. II.—The Metals. Fifth Edition. Macmillan & Co., Ltd., London, 1913. Pages 1,470 + xvi, with Index. Divided into VIII. Sections with 211 Illustrations. Price 30/- net.

"Introduction to Modern Inorganic Chemistry," by J. W. Mellor. Longmans Green & Co., London, 1914. Pages 682 + viii, with Index. Chapters XXXVII., including Appendix and 232 Illustrations. Price 4/6.

"An Electrolytic Method of Preventing Corrosion of Iron and Steel," by J. K. Clement and L. V. Walker. Technical Paper 15, Bureau of Mines, Washington, U.S.A., 1913. Pages 19, with 10 Illustrations and 2 Tables.

"Portable Electric Mine Lamps," by H. H. Clark. Technical Paper 47, Bureau of Mines, Washington, U.S.A., 1913. Pages 13.

"Monthly Statement of Coal Mine Fatalities in the United States, June, 1913." Compiled by Albert H. Fay. Bureau of Mines, Washington, U.S.A., 1913. Pages 17.

"The Flash Point of Oils." Methods and Apparatus for its Determination, by Irving C. Allen and A. S. Crossfield. Technical Paper 49, Bureau of Mines, Washington, U.S.A., 1913. Pages 31, with 2 Illustrations.

"Monthly Statement of Coal Mine Fatalities in the United States, May, 1913." Compiled by Albert H. Fay. Bureau of Mines, Washington, U.S.A., 1913. Pages 15.

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, Chartered Patent Agent,
Queen Anne's Chambers, Westminster, S.W.

26077/12. A. STOLTE. Filtering Gases.

The process of dry filtering furnace gases consists in cooling the gases far below their point of saturation and eliminating the water of condensation, in then heating the gases to above their new point of saturation, and in subsequently filtering the same.

26743/12. A. SHELMEERDINE. Sterilising Milk.

In effecting the sterilisation of milk by the electrical method or process, the milk is subjected to the action of an alternating electric current at a pressure of 2,000 to 3,000 volts or more.

26884/12. R. KOLOWRATNIK. Explosives.

In the manufacture of explosives containing as base picric acid and as the remaining components carboniferous substances and substances giving off oxygen, a portion of the oxygen carriers (chlorates and nitrates) is made, by means of hot water (between 50° C. and 90° C.), into an unsaturated solution, in which is dissolved the whole of the picric acid in such a way that a thick fluid or pasty substance results, this latter being absorbed in its turn by the dry mixture of the carboniferous substances and the remaining portion of the oxygen carriers.

27320/12. R. H. KENDALL. Treating Metalliferous Slimes.

Apparatus for treating metalliferous sands or slimes comprises, in combination, an agitator, a settling tank surrounding the upper portion of the agitator, means for discharging the thickened pulp from the settling tank into the agitator, and means for removing the pulp after agitation from the agitator.

27378/12. J. U. LLOYD. Alkaloids and Alkaloidal Salts.

For extracting alkaloids or alkaloidal compounds from solutions or materials containing them, the alkaloid or compound thereof is caused to separate in the presence of a non-alkaline solvent of the material, or from a non-alkaline solution by means of an insoluble silicate of a metal of the aluminium group.

27718/12. F. BEDFORD and E. ERDMANN. Preparing Catalysts.

A process for the preparation of very voluminous and light metallic oxides suitable for catalytic reactions consists in mixing the nitrate of the metal whose oxide is to be obtained in concentrated solution with organic compounds soluble in water and rich in carbon, and subsequently decomposing by heat.

27968/12. G. H. BENJAMIN. Iron Purification.

A process for refining iron containing carbon and phosphorus consists in heating the impure iron with excess of lime in absence of oxidising substances in an electric furnace.

28584/12. J. L. PALMER. Decorticating Machines.

A decorticating machine comprises a travelling bed adapted to feed the material to be decorticated through the machine and a plurality of revoluble hammers, strikers or decorticators arranged over the bed and adapted to remove the bark from the material, or to loosen the same thereon, when, on being rotated, they strike the same.

28953/12. P. MARINO. Electrolytes.

Electrolytes for use in electrolytic deposition are prepared by adding ammonium, sodium or potassium salicylate to an aqueous solution of the salt, or oxide, or salicylate of the metal to be deposited, and then rendering the bath alkaline by the addition of ammonium.

1812/13. THE KNOWLES OXYGEN CO., LTD., and R. W. GRANT. Hydrogen and Oxygen.

In the production of hydrogen and oxygen by electrolytic processes, the electrolyte is subjected to a preliminary electrolytic purification process before the decomposition of it in the cells in the electrolytic process.

11854/13. SPRENGSTOFF, A. G. Improvements in or relating to the Denitration of Waste Acids containing Dissolved Organic Substances.

14058/13. L. SCHÖN. Heat Insulating Compound.

A process for the production of a heat insulating compound is characterised by the fact that a mixture is made of magnesium carbonate, 80 parts, with silk, 10 parts, asbestos fibre, 10 parts, and glue powder, 1½ parts, and converted into a paste by means of water, when the glue is hardened.

7945/13. FARBENFABRIKEN, VORMALS FRIEDRICH BAYER & CO. Caoutchouc-like Substances.

Caoutchouc-like substances are produced from butadiene and its homologues by submitting these hydrocarbons to the action of sodium or other light metals which have been superficially oxidised until they are quite white.

7707/13. F. L. SMITH & CO. Ore Treatment.

In a process for the agglomeration of ores in a rotary tubular furnace, the ore is heated with a reducing action in an enlarged portion or zone of the furnace, and in passing the step confining the enlarged zone towards the outlet is subjected to an oxidising air current against the action of which the hot material reduced or to be reduced in the enlargement is protected by the step arranged for that purpose.

17582/13. L. FEVAL and J. DE LA FRESNAYS. Caoutchouc.

In a process for the treatment of caoutchouc, gutta-percha and like substances, castor oil is utilised as a solvent for the extraction of resin, either alone or in conjunction with another solvent or mixture of solvents.

5999/13. R. OLIVER. Preserving Fresh Fruit.

A process of preserving fresh fruit in a natural condition for use in confectionery consists in immersing the fruit in an aqueous solution of sodium bisulphite with the addition of common salt, if desired, the fruit being subsequently rinsed with water.

7907/13. A. DENNY and D. G. ANDERSON. Flooring Composition.

A composition for flooring and like purposes comprises as ingredients calcined gypsum, sawdust, a solution of glue, a tanning agent, such as chrome alum or formaldehyde, and with or without a preservative of the glue.

9247/13. CHEMISCHE WERKE, VORMALS DR. HEINRICH BYK, F. L. SCHMIDT, and R. GRÜTER. Washing and Bleaching.

A process for washing and bleaching by means of solutions of per salts or hydrogen peroxide is characterised by the addition of a small quantity of a compound of tin or titanium to the per compounds, or to mixtures containing same.

11471/13. H. H. GREENWAY and A. H. P. LOWRY. **Ore Concentration.**

A process for the concentration of metallic sulphide ores consists in subjecting the ores to the action of a chromium salt, either before or during the froth flotation separation process, whereby a flotation product relatively high in certain sulphides is obtained.

11758/13. G. F. HULTMAN. **Coal Gas Purification.**

For removing or recovering from coal gas substances, such as sulphur compounds, benzol, naphthalene, the coal gas is washed with alcohol cooled to 0° C. or below, or with

some other washing liquid cooled to the same temperature and possessing the same characteristic quality as alcohol, of being able, at the same temperature, to prevent freezing of the moisture separated from the gas on account of the low temperature, and to dissolve the said substances.

13825/13. C. K. F. L. GROSS. **Isoprene.**

For manufacturing isoprene from turpentine oil, the vapours of the oil are brought at a temperature below 700° C. into contact with one or more metal oxides, or with one or more metal hydroxides, or with one or more basic metal salts.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

A New Quinine Factory in Java.

The quinine factory in Bandoeng, Java, which recently started operations, is very actively engaged in filling orders "direct to dealers" for drug preparations of quinine freshly made right in the heart of the greatest quinine producing district of the world. Shipments of the crude bark to the United States and Europe continue, of course, on a large scale. In this connection it is interesting to remember that the Dutch chemists, by the application of modern scientific methods of plant breeding, have increased the quinine contents of certain varieties of chincona under cultivation in Java from 7% to 15%.

Delta Cellulose in Roumania.

Reed pulp, known commercially as delta cellulose, is now manufactured on a large scale, chiefly at Braila, Roumania, as a raw material for paper making. Its chief microscopic characteristic is the presence of tubular vessels having slit-like pores arranged in rows over almost their entire surface. The epidermal cells are thinner and have more uniform crenatures, the parenchyma cells are usually longer and less numerous, and the libriform cells are smaller and shorter than those of straw pulp. Esparto pulp is distinguished by the regular cylindrical form of the fibres and the almost complete absence of parenchyma cells.

The Use of Preservatives in Lime Juice Cordial.

The preparation of lime juice cordials is the subject of comment by the Medical Officer of Health for Paddington in his annual report. He states that thirty-seven samples were procured, and, so far as could be ascertained, each sample was the product of a different maker. As, however, many of the bottles bore labels with the vendors' and not the manufacturers' names, and others had labels without any names, there was probably some duplication of the samples. Eleven of the samples were found to be free from preservatives. In the others salicylates were found in amounts varying from 1.00 to 7.75 grs. (calculated as salicylic acid) per pint. The prices of the eleven "free" samples ranged from 6½d. to 1s. per pint, and those of the samples with preservatives from 7½d. to 1s. 2d. Dr. Duffield adds that the results of the analyses were reported to the manufacturers concerned and a good deal of corre-

spondence ensued. Certain firms referred to the first recommendation of the Departmental Committee on the Use of Preservatives in Foods as sanctioning the use of small amounts of salicylates; but apparently the last sentence of that recommendation—"Its (*i.e.*, the preservative's) presence in all cases to be declared"—had been overlooked. In no instance was there any mention of the addition of preservatives on the label. From one firm it was ascertained that "lime juice" is imported in two forms: one mixed with the fruit pulp, and the other free from pulp. It was stated that in the latter sulphates might be expected to be found, but that the other required no preservative, the vegetable acids in the pulp having sufficient preservative powers.

The Chemical Industry of the United States.

The United States Bureau of Census has just made public the final statistics of the manufacture of chemicals in the United States for the census year of 1909. These details are presented in a bulletin which is about to be issued by the Bureau, and a summary of the details, as prepared by the Bureau officials, shows that chemicals to the value of \$117,000,000 were produced in that census year, whereas the cost of materials amounted to about \$64,000,000. The following details are of special interest to the chemical trade:—

"The total number of establishments in the United States engaged in the manufacture of chemicals in 1909 was 349, as compared with 297 in 1899; the number of persons engaged in the industry was 27,791, of whom 23,714 were wage-earners; the capital invested amounted to \$155,143,739; the wages paid out amounted to \$14,084,501; the cost of materials was \$64,121,536, and the value of products was \$117,688,887. The number of establishments increased by 17.5% during the decade from 1899 to 1909; the average number of wage-earners employed by 57%; the value of products by 145%, and the value added by manufacture by 155.3%."

Proposed Increase of the Production of Bichromate of Soda.

The announcement that certain manufacturers of bichromate of soda in the United States have planned to extend their operations for the coming year has created some surprise in trade circles, as the market for the last

year has been handicapped by almost unabated selling pressure to move the liberal volume of production, keeping values at a relatively low level. The principal channels of consumption are the textile, leather and colour industries, and in none of these fields have recent trading conditions been of a character to offer any encouragement for more than the usual requirements during 1914.

Leaders in the movement to increase the production are two concerns who are recognised as factors both in the manufacturing and marketing branches, and they are presumed to be in touch with every material phase of the business. The future trend of the market is attracting wide speculation and with the various underlying conditions there is unusual latitude for interesting developments.

Adulterated Oil of Birch and Oil of Wintergreen in the United States.

The practice of adulterating the natural oils of birch and oil of wintergreen with methyl salicylate has grown among American dealers because they believed that there was no chemical method by which the addition of the methyl salicylate could be detected. The specialists of the Bureau of Chemistry, however, are now able to detect any fraud of this kind, and the consequence is that a great number of shipments are being seized by the Government. Quite recently twelve shipments, consisting of nine packages and nineteen cans, purporting to contain oil of birch or oil of wintergreen have been seized on the ground that the products were adulterated and misbranded, a proceeding which caused some consternation among dealers and shippers of the oils in question.

Government Controls Hong Kong Opium Traffic.

The annual budget for the colony of Hong Kong makes radical changes in the opium policy, in that the opium monopoly, which has existed for many years, has been abolished, and the Government takes charge of the sale of the drug in that province. The intention of the Government is not to make added profit from the business, but to "maintain a stricter and closer control over the use of opium." The chief serious question presented in the new legislation is as to whether or not the present business in exporting opium to countries that still permit its importation will be continued by the Government under the new arrangement. The new system is substantially the same as that which has been operated for several years in the Straits Settlements, and the superintendent of the imports and exports of Hong Kong recently spent some time in Singapore studying the operation of the Government monopoly there. It is believed that a much more satisfactory control of the use of opium in the colony and its sale abroad can be effected by the new arrangement.

Monkey-Bread Tree Oil from Madagascar.

According to the *Organ für Öl und Fett-Handel*, attempts are being made in Madagascar to utilise the oil of the baobab or monkey-bread tree, which is particularly abundant in that island, as well as in Africa and Australia. The fruit of this tree is often as much as 20 ins. in length, and contains numerous seeds capable of yielding oil. There are three varieties of this tree, which ripen at different times and differ in the percentage of oil furnished by the seeds. The method of extraction pursued by the natives consists in removing the seeds from the fruit and crushing them in a mortar to a pulpy mass, which is mixed with water and

boiled for a considerable time, the oil collecting on the surface ready to be skimmed off. This primitive method is, of course, capable of being improved. European methods applied for the same purpose result in extracting almost four times as much oil from a given quantity of seeds as those in use with the natives. The oil is suitable for edible purposes, whilst the residue can be used for cattle foods.

Artificial Silk on the Continent.

The artificial silk industry on the Continent has been the scene of some interesting developments in recent years, caused chiefly by the surprising progress of the viscose process. The example of the "Vereinigten Glanzstoffabriken" at Elberfeld—the largest Continental concern producing artificial silk—has recently been followed by another important firm, the "Vereinigten Kunstseidefabriken," Frankfurt o. M. The latter company has been very successful at first, but during the last two years the financial results were most unsatisfactory, which caused the directors to adopt the viscose process of manufacture. The only concerns capable of working the collodium process with marked success were the Belgian makers, who had the advantage of very cheap industrial alcohol. But even they find it increasingly difficult to compete with other Continental manufacturers of viscose silk and one after another is obliged to change his methods of production.

According to a recent report the "Soie Artificielle de Tubize" and "Fabrique de Soie Artificielle d'Obourg" have also acquired the rights of manufacture by the viscose process, and they intend to entirely discontinue the nitro-cellulose process. The former company has increased the working capital by 2,000,000 francs in order to enlarge its operations in the manufacture of viscose silk.

A French company has recently introduced a new artificial silk which is called "Cellophane" and "Viscolith." The manufacturing rights of the invention for Germany have been acquired by "Chemische Fabriken Heidenau," near Dresden.

M. L.

CONSULAR REPORTS.

Drugs Wanted in the United States.

H.M. Consul-General at New York reports that a firm in that city wishes to get into communication with United Kingdom exporters of arnica flowers, Calabar bean, dandelion root, lily of the valley root, belladonna leaves, colchicum root, ergot, stramonium leaves, sarsaparilla root (Mexican), buchu, digitalis, gentian, and henbane. The name and address of the inquirers may be obtained by British manufacturers of the goods mentioned on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall Street, E.C.

Cactus Plant as a Source of Resin.

In a report which the American Bureau of Foreign and Domestic Commerce received from Mexico, reference is made to the utilisation of the cactus plant as a source of resin. It appears that a report was printed in the official gazette of the Ensenada district describing the analysis of the bark of the cactus plant. According to the American Vice-Consul of that district this analysis appears to indicate that the resin content of the dead plant is sufficient in quantity and easily enough extracted to make its utilisation practicable some time in the future if not at present.

Experiments performed in the central agricultural station gave the following chemical analysis of a sample of the bark referred to: part soluble in alcohol (resin, chlorophyll, etc.), 47.20%; part of the residue treated with alcohol soluble in acetone, 0.72%; part of the residue treated with acetone soluble in ordinary ether, 0.80%; ash, 4.06%; organic matter insoluble in the agents used, 47.22%.

For the purpose of obtaining a resin almost pure and free from other substances, that might have been dissolved by the alcohol, the sample was treated with other solvents and the following results were obtained: essence of turpentine dissolved, 35.71%; naphtha (petroleum ether) dissolved, 35.32%; ordinary ether dissolved, 35.12%.

Casein Obtained by Electrolysis.

In an American consular report from St. Etienne, France, reference is made to the different industrial uses of casein. According to the uses to which it is to be put, casein undergoes mechanical and physical treatments with a view of transforming it into powder, or thoroughly purifying and drying it to facilitate its preservation. Very recently casein was obtained by electrolysis, as follows:

In the middle of a large vat full of skimmed milk heated to a temperature of 80° C., a porous vessel is placed containing a 5% solution of caustic soda; an iron cathode is plunged into the soda and a rod of carbon, serving as anode, into the milk. The two electrodes are 3 ins. apart. By sending through the apparatus a current of a density of 1 ampere per square centimetre of the anode, the phosphoric acid contained in the milk is entirely set free, and the casein precipitates. With a current of 160 ampere under 11 volts it is possible, in twenty minutes only, to coagulate completely the casein from 100 litres of skimmed milk. The caustic soda can be replaced by an equal volume of skimmed milk derived from a preceding operation, the electrodes being disposed in the same manner. With a current of 160 ampere under 18 volts, ten minutes are sufficient to precipitate the casein of 100 litres of skimmed milk. This method, due to Gateau, presents three important advantages:—

The production is greater because the weight of casein thus obtained is superior to that obtained by acids or rennet.

The cost is very low, electric power being cheaper than acids or rennet, especially when produced by water or wind power.

Casein thus obtained contains no impurities; foreign elements cannot enter the product, as the precipitation is effected by the electric current alone.

Poland's Importation of Chemical Fertilisers.

According to a British consular report the use of artificial manures is rapidly extending in Poland, as the figures of the agricultural societies prove. With the exception of superphosphates, of which a large proportion is manufactured in the country, all other manures are imported in a finished condition. As a complement to the more extended use of superphosphates and basic slag, the quantities of nitrate of soda used increased considerably. The introduction of the use of artificial nitrate of soda as an article of agricultural consumption, mentioned in a former report, became more general, and there are grounds for belief that, in the future, it will compete on level terms with the natural product.

Up to the present sulphate of ammonia has only been made in one chemical factory in Poland, but the output

was sufficient to meet the demands of the market. Large chemical plants are, however, in the course of construction in South Russia for the production of this article, which will probably lead to a fall in the price, thereby creating a serious competitor to the use of nitrate of soda.

The Chemical Industry of Poland.

The market for sulphuric acid showed a steady demand during 1912, and the price rose from 3s. 6½d. to 3s. 11½d. per cwt. All works producing this article are syndicated, and the import in face of the heavy import duty is very small.

Although the demand for hydrochloric acid was even larger than in the previous year, prices could not be raised, owing to over-production and competition. Attempts to form a syndicate were only partially successful.

Aniline dyes, which were up to a few years ago solely imported from Germany, are now manufactured near Lodz, and the local articles compete successfully with those imported.

The demand was so large as to necessitate a considerable extension of the present plant, which has already been commenced.

There is a very visible increase in the sale of British and American patent medicines, which appear to be ousting German preparations.

MARKET REPORTS.

LONDON.—Notwithstanding the gradual decline of the foreign demand for chemicals towards the end of last year, the total results of the export trade in 1913 must be called quite satisfactory, as the trade statistics reveal a further considerable gain in value. The total value of chemicals, drugs, dyes, and colours (produced and manufactured in the United Kingdom) reached the commanding figure of £22,012,238, against £21,036,390 in 1912, and £20,053,129 in 1911. The lion's share of the increase is due to the section for coal products, not dyes. The exports of these rose from £1,880,253 in 1911 to £2,249,892 in 1912, and £2,665,652 in 1913, but chemical manures, particularly sulphate of ammonia, have also helped to swell the export figures by rising from £3,819,747 two years ago to £4,411,920 last year. The prospects for the current year do not appear quite as good as they did twelve months ago, although there is no reason to fear a continued slump. There are still many manufacturers of chemicals who are well provided with orders for some time to come, and if nothing unforeseen occurs to upset the general trade of the world, it is quite likely that the conditions will gradually improve once more.

The markets for chemical fertilisers are still rather quiet, and sulphate of ammonia has developed further weakness. The American demand for this product has been very disappointing lately, and the large increase of the production in the United States does not offer much hope for a revival of the trade with this market. The total shipments of sulphate of ammonia in 1913 amounted to 324,704 tons, representing an increase of about 38,000 tons in comparison with 1912. The home demand is very moderate, though it may be expected to become more active in the immediate future. The quotation for grey 25% quality for prompt delivery is £12. Nitrate of soda keeps fairly steady, in spite of little inquiry and weakening

reports from the Continent. Ordinary quality is sold at 10s. 6d., and refined at 10s. 9d. Tar products have been very quiet lately. Business in pitch is difficult to arrange, as sellers are still reluctant to grant concessions, hoping for an early revival of the demand. Small quantities have been offered at 39s.—40s., but in the majority of cases the makers stand out for more. Shipments against older contracts continue at a good rate. The home demand for benzols is keeping up fairly well, but the export buyers show a great reluctance against contracting for later shipment. 50% benzol for prompt delivery is now obtainable at 11½d.—1s., and 90% quality is held at 1s. 1d. per gallon. The naphthalene business continues very satisfactory. There are no stocks accumulating, as the whole production is being absorbed by the consumers at good prices. Solvent naphtha tends distinctly upwards, and the makers seem determined to bring about a further rise. The latest price was 10½d.—11d. Heavy naphtha in casks is quoted at 11½d.—1s. Carbolic acid has once more relapsed into a state of complete apathy. The nominal quotation for crude, 60% quality, prompt is 1s. 1d.—1s. 1½d. Crystals are quite neglected, though prompt delivery may be had at 3½d. per lb.

Bromides have enjoyed a more active demand than usual, and the reports from abroad denote fair transactions. This led to suggestions of a rise in prices, which, however, is not at all likely. The official quotation is 1s. 6½d. per lb. net for potassium bromide, in 1 cwt. lots, with an occasional seller at slightly below. Anything obtainable from second hand at less than maker's price is quickly snapped up.

MANCHESTER.—The year's exports of heavy chemicals are considered quite satisfactory, but in consequence of the gradual slackening off during the last few months the prospects for 1914 appear not particularly bright. Citric acid is still very dear, though the price has recently shown some tendency to weaken, and sellers were prepared to sell any quantity at 1s. 11½d. Cream of tartar tends upwards at 95s. for 99—100%. Soda products have not altered very much. Caustic soda is quoted at £8 10s.—£10 2s. 6d.; liquor at £10 5s.; ammonia alkali at 65s.; soda crystals at 42s. 6d.; bicarbonate of soda at 70—100s.; and phosphate of soda at 9s. per cwt. Alumina products keep steady with continued demand. Present figures: crystal alum, lump, £5 17s. 6d.—£6 12s. 6d., and ground £6 12s. 6d.—£7 7s. 6d. per ton on rails, Lancashire or Yorkshire, or f.o.b. Hull, Goole, or Liverpool.

LIVERPOOL.—The chemical market has remained very quiet. Sulphate of copper has experienced some inquiry, but the bids were considered too unprofitable to be accepted and the business was disappointing. The official quotation has gone down to £22 2s. 6d. The home demand for bleaching powder against contracts is very fair, but new business is scarce, and the American buyers are keeping off the market. Sulphate of ammonia has not improved in any direction. Makers still quote 2s. 6d. more for forward delivery, though unable to obtain it. The quotation for prompt delivery is £13 10s.—£13 15s. The market for nitrate of soda is without any special feature. The prices keep steady, but the business is limited. Ordinary 95—96% quality is held at £10 10s., and refined at £10 15s. Cream of tartar favours sellers. Tartaric acid is firm at 12¼d.—12¾d.

GLASGOW.—The general aspect of the chemical market has now a normal appearance, and the prospects may be considered fairly promising. The recent inquiry for alkali produce has been fairly good, though fears of lower

prices prevent buyers from taking more than their actual requirements. Coal tar products are steady but quiet.

Metal Markets.

LONDON.—The copper market remains under the influence of the very poor American statistics which showed the remarkable increase in the stocks of 19,400 tons. The consumers are showing distinct reluctance to operate in view of the uncertainty of the position, and the general conditions do not favour speculative operations. Reports from the Continental trades are not very encouraging, and demands from that quarter for refined copper have been limited to small lots, while the home trade was equally moderate. Producers' terms for electrolytic have been reduced to about £65 15s. Business in manufactured copper has been featureless, India being for the time virtually out of the market. Standard copper rose on account of reports of another strike at the Rio Tinto mines, forward metal reaching £64 10s.—£64 15s. Tin has been rather steady, but the condition of the market does not encourage bull speculators to try another campaign. The supply of the metal has overtaken the demand, and there is no sign of an early improvement of the statistical position, unless the trade becomes more active. Recent arrivals were again on a liberal scale, and the London stocks amount to 2,660 tons. America has not bought much tin recently, though in view of the greater activity of the American tin-plate mills renewed demand may be expected. The quotation for Straits tin was £171—£171 10s. Lead has shown a great firmness, and quite a large business has been put through at advancing prices. Dealings were most numerous in March and April—May deliveries, owing, no doubt, to the continued acute scarcity in near delivery. A further rise in prices seems likely. There are practically no sellers of prompt metal, which is nominally quoted at about £20. Spelter remains quiet with a downward tendency. Consumers stocks are, however, getting low, and new orders are likely to come in more freely. April delivery has been sold at £22. The syndicate's limits stand at £21 12s. 6d.—£21 17s. 6d., according to position.

TRADE ITEMS.

The new "half-watt" incandescent lamp is now on the market. It is a tungsten filament lamp, working in an atmosphere of nitrogen. It works at 50 to 65 volts range. The price ranges up to 60s. for 3,000 candle-power size. It is claimed that this system can replace arc lighting with advantage at reduced cost.

FINANCIAL NOTES.

The Mond Nickel Co. recently offered to shareholders and debenture holders the unissued balance of 20,000 7% cumulative preference shares of £5 each at 15s. premium.

The Birmingham Aluminium Casting (1903) Co., Ltd., have recently offered a further issue of 17,500 ordinary shares. They report a steady progress in output and profits, and that they have purchased the British and Colonial rights of the Cothias process for casting aluminium. They expect as a result a further extension in output and profits. The dividend for the last two years has been at the rate of 10%. The company has contracts running with leading motor-car manufacturers.

Recent developments at Maikop have given three fresh strikes of oil, at a depth of 790 ft., in the case of a Victory Co. well.

Chemische Industrie "Weser" G.m.b.H. is the title of a new company which has been formed at Bremen with the object of manufacturing all kinds of chemical products. The capital of the concern is 30,000 marks.

The Chemische Produktenfabrik at Thann (Alsace-Lorraine) obtained a net profit of 53,624 marks for the past financial year which compares with a loss of 354,000 marks, the result of the previous year's trading. The reserve of the company now amounts to 241,547 marks.

The A. G. der Chemischen Fabrik Pommerensdorf at Stettin will shortly raise its capital by 2,310,000 marks to 4,500,000 marks.

The soda section of the Schleswig-Holsteinische Chemische Fabrik, Edlinger, Ancker & Co. at Kiel-Gaarden has been transferred to the Schleswig-Holsteinische Fabrik m.b.H. at Kiel. Capital 50,000 marks.

Handelsgesellschaft fuer chemische Produkte, G.m.b.H. has been registered with a capital of 20,000 marks. The object of the company is to manufacture chemical products at Charlottenburg, near Berlin. L. F. Neirath of Berlin-Wilmersdorf is managing director.

The Oesterreichische Chemische Werke A. G. in Vienna have reduced their capital from 1,200,000 kr. to 1,050,000 kr.

The Chemische Fabrik Griesheim-Elektron and the Metallurgische Gesellschaft A. G. at Frankfort-on-the-Main have formed a new company, trading as Elektrometallurgische Werke A. G. at Horrem, near Cologne. The capital of the latter is 1,000,000 marks. The new concern will, at first, lay down an experimental plant.

The Norddeutsche Spritwerke at Hamburg report a gross profit of 1,367,860 marks (1,454,686 marks last year), and a net profit of only 369,394 (441,994) marks. The dividend will be 16%, the same as last year.

The Chemische Fabrik at Tabor have opened negotiations with the German Glue Syndicate in order to join this trust.

NEW COMPANIES.

BIO-CHEMICAL CO., LTD.—Registered in Edinburgh. Capital, £2,500 in £1 shares. Object: To acquire patented invention for improvements in preparation of diastase substances, and to carry on the business of manufacturers of all kinds of chemicals. Private company. Registered office: 30, George Square, Glasgow.

AZOTINE, LTD.—Registered in Edinburgh. Capital, £10,000 in £1 shares (2,000 pref.). Object: To carry on the business of manufacturers of fertilisers known as "Azotine." Signatories: J. J. D. Main, Public Wharf, Leicester, and H. F. Stevenson, 21, West Nile Street, Glasgow. Private company.

KENTOL SYNDICATE, LTD.—Capital, £1,000 in £1 shares. Object: To carry on the business of manufacturers of smokeless fuel by a process of low temperature distillation of coal *in vacuo* and of motor spirit, sulphate of ammonia, etc., and to adopt an agreement with the Premier Tarless Fuels Ltd., of 91 and 93, Bishopsgate, E.C. Registered office: 18, Queen Anne's Chambers, Tothill Street, Westminster.

SODIUM SYNDICATE, LTD.—Capital, £50,000. Object: To acquire freehold and leasehold rock salt, brine and other lands, to sink shafts and wells and make borings, to carry on the business of producers and manufacturers of and dealers in salt and other minerals, etc. Signatories: H. C. Shaw, 48, Church Road, Southgate Road, N., and H. Preedy, 150, Brooke Road, Stoke Newington, N.

UNITED WATER SOFTENERS, LTD.—Capital, £30,000. Object: To acquire, deal with, grant or take licences in respect of, develop and turn to account patents, patent rights, and processes for the softening, purification or other treatment of water for industrial and domestic purposes, and to adopt an agreement with Water Softeners, Ltd., and Lassen and Hjort. Signatories: A. O. Burton, 22, Austin Friars, E.C., and J. J. Lassen, 52, Queen Victoria Street, E.C.

SHARE LIST.

Name of Company.	January 24th.		December 24th.	
Alby United Carbide	1 ² / ₃	1 ² / ₃	1 ⁹ / ₁₆	1 ¹¹ / ₁₆ xd
Ditto. Pref.	1 ¹ / ₁₆	1 ¹ / ₁₆	1	1 ¹ / ₁₆
Associated Portland Cement. (10)	6	6 ¹ / ₁₆	6 ¹ / ₁₆	6 ¹ / ₁₆
Ditto. Pref. (10)	8 ⁹ / ₁₆	8 ¹³ / ₁₆	8 ⁷ / ₁₆	8 ¹³ / ₁₆
Babcock-Wilcox. Ord.	2 ¹ / ₁₆	2 ¹ / ₁₆	2 ¹ / ₁₆	2 ¹ / ₁₆
Ditto. Pref.	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Bell's United Asbestos	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Bleachers' Association. Ord. ..	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆ xd
Ditto. Pref.	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Borax Consolidated. Pfd. (5) ..	5 ¹ / ₁₆	5 ¹ / ₁₆	5 ¹ / ₁₆	5 ¹ / ₁₆
Ditto. Defd.	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Ditto. Pref. (10)	11 ¹ / ₁₆	11 ¹ / ₁₆	11 ¹ / ₁₆	11 ¹ / ₁₆
Bradford Dyers	1 ¹ / ₁₆	1 ¹ / ₁₆	1	1 ¹ / ₁₆
Ditto. Pref.	1 ¹ / ₁₆	1 ¹ / ₁₆	1	1 ¹ / ₁₆
British Oil and Cake. Ord. ..	4 ¹ / ₁₆	4 ¹ / ₁₆	4 ¹ / ₁₆	4 ¹ / ₁₆
Brunner Mond. Ord.	14 ¹ / ₁₆	15 ¹ / ₁₆	14 ¹ / ₁₆	14 ¹ / ₁₆
Ditto. 7% Pref. (10)	2 ¹ / ₁₆	2 ¹ / ₁₆	2 ¹ / ₁₆	2 ¹ / ₁₆
Bryant and May. Pref.	2 ¹ / ₁₆	2 ¹ / ₁₆	2 ¹ / ₁₆	2 ¹ / ₁₆
Calico Printers	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Ditto. Pref.	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Castner Kellner	2 ¹ / ₁₆	2 ¹ / ₁₆	3 ¹ / ₁₆	3 ¹ / ₁₆
Commercial Salt. (2/-)	8 ¹ / ₁₆	8 ¹ / ₁₆	8 ¹ / ₁₆	8 ¹ / ₁₆
Crossley & Sons. (2)	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Ditto. 5% Pref.	4 ¹ / ₁₆	5	4 ¹ / ₁₆	5
Eastman Kodak. (\$100)	610	650	470	520
Eley Brothers	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Fraser and Chalmers. (£3)	1 ¹ / ₁₆	1	1 ¹ / ₁₆	1
Gas Light and Coke. (S.)	101 ¹ / ₁₆	103 ¹ / ₁₆	102	104
Ditto. 4% Pref. (S)	94	97	93	98
Greenwich Lino. (½)	1 ¹ / ₁₆	1 ¹ / ₁₆ xd.	1 ¹ / ₁₆	1 ¹ / ₁₆
Harrison and Crossfield. Pref. ..	1 ¹ / ₁₆	1 ¹ / ₁₆ xd.	1 ¹ / ₁₆	1 ¹ / ₁₆
Imperial Continental. (S)	170	175	160	165xd
Ditto. 3½% Debenture (S)	83 ¹ / ₁₆	85 ¹ / ₁₆	83 ¹ / ₁₆	85 ¹ / ₁₆
India Rubber Co. (10)	11	12	11 ¹ / ₁₆	12 ¹ / ₁₆
International Salt	6/6	7/6	5/-	6/-
Ditto. Pref. (5/6 pd.)	2 ¹ / ₁₆	2 ¹ / ₁₆	1 ¹ / ₁₆	2
Lever Brothers. 1st Pref. (10) ..	10 ¹ / ₁₆	11 ¹ / ₁₆	11	11 ¹ / ₁₆
Lister & Co. Ord.	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Mappin & Webb. Ord.	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Neuch'tel' Asphalt. (10/-)	9 ¹ / ₁₆	9 ¹ / ₁₆	9 ¹ / ₁₆	9 ¹ / ₁₆
Nobel Dynamite. (10)	17 ¹ / ₁₆	18 ¹ / ₁₆	16 ¹ / ₁₆	17 ¹ / ₁₆
Ditto. Bearer (10)	17 ¹ / ₁₆	18 ¹ / ₁₆	17	17 ¹ / ₁₆
Ditto. 5% Pref. (10)	10 ¹ / ₁₆	11 ¹ / ₁₆	10	11
Pears, A. and F. Ord.	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
Ditto. 6% Pref. (10)	12 ¹ / ₁₆	12 ¹ / ₁₆	12 ¹ / ₁₆	12 ¹ / ₁₆
Price's Candle. (16)	35	37	34 ¹ / ₁₆	36 ¹ / ₁₆
Rosario (5)	9 ¹ / ₁₆	9 ¹ / ₁₆	8 ¹ / ₁₆	8 ¹ / ₁₆
Salt Union. (4)	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆
South Metropolitan 4% Standard (S)	110 ¹ / ₁₆	112 ¹ / ₁₆	108	110
Ditto. 3% Debenture (S)	71 ¹ / ₁₆	73 ¹ / ₁₆ xd.	72	74
United Alkali. (10)	1 ¹ / ₁₆	1 ¹ / ₁₆	1	1 ¹ / ₁₆
Ditto. Pref. (10)	7 ¹ / ₁₆	8 ¹ / ₁₆	7 ¹ / ₁₆	8
Val de Travers	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆	1 ¹ / ₁₆



THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY W. P. DREAPER, F.I.C.

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

VOL. III. No. 3.

MARCH, 1914.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
" " Abroad 8s. " "

Motor Fuels.

The subject of the possible use of alcohol is again to the front. A recent paper by W. R. Ormandy summarises the position once more and brings the subject up to date.

The chief factor in favour of a supply of alcohol is that it can be manufactured from present-day products. That there is not the chance of the raw material running out as in the case of petroleum products, or coal.

Although it is always possible that a new product may take the place of present spirits as they are known to-day, or that the whole method of obtaining energy may be altered and become more direct, yet, so far as can be seen, there is a reasonable chance that alcohol may become the future fuel.

It is not generally realised in this country that thousands of alcohol engines are already utilised in Germany in agriculture. They are of the high-compression, slow-running type. Little has been done with the high-speed type of engine, and probably the most important research work in this direction is that referred to in a previous issue as having been carried out in America under Government supervision.

Dr. Ormandy referred to some work he had recently carried out in this country with mixtures of benzene and alcohol, and the results, so far as they go, are stated to be satisfactory. Alcohol can be used without any danger of pre-ignition under high compression; it can yield a higher percentage of energy in the form of work; and it has certain advantages which should aid it in the carburetter.

In 1904 a Departmental Committee on Industrial Alcohol reported that they were at that time adverse to any immediate change which might favour its use for motor purposes, but their conclusions were not of a final nature. It is evident that a good deal of work and thought will be given to this matter in the near future; and it is highly necessary that our Government should give some direct aid in this direction, as the matter is one of some moment, even at the present time, so far as the economy of different fuel mixtures is concerned.

Sir Boverton Redwood, in the discussion following the paper, stated that the annual cost of running

motor-cars and vehicles in this country was somewhere about £100,000,000; and this brought a benefit, directly or indirectly, to British labour of a sum of £37,500,000. That something like 1,000,000 of the population were supported by the industry of motoring.

These figures are startling, and illustrate the rapid utilisation of new ideas under modern conditions. They seem to indicate that there will be little chance in the future of any shortage of work for skilled labour, which will rather be hard pressed to keep pace with the demands set up by the application of scientific research to industry.

It is interesting to speculate whether the future supply of alcohol could be derived from British sources; or if, as Professor Armstrong suggested, the greater facilities present in the more tropical regions of the earth's surface will not determine its manufacture elsewhere. One thing is clear, that it will be connected in some way or other with agriculture. One of the chief factors which will determine its future use will probably be the cost of distilling plant.

Hormones or Hops.

The recent paper read by Professor Armstrong before the Institute of Brewing on the properties of alcohol in relation to its physiological effects, summarises recent work in this direction, and calls attention to the fact that the deleterious effect of alcoholic beverages may not be due to the alcohol present but to the hops, or the higher alcohols.

This view seems to be gaining converts since Traube and Overton showed that as the molecular weight increases in a series of alcohols the toxic effect rises rapidly.

It was also claimed by the reader of this paper that the effect of a highly "hopped" beer was immediately felt, and that this effect was absent in the German beers.

Professor Armstrong held "that it was useless to throw stones at ethylic alcohol alone, for though this was a characteristic constituent of all fermented beverages, it is by no means certain that it gives rise to the effects which make such beverages unpopular with a certain class of society."

Here the matter must be left for the present, but the line of research indicated is certainly an interesting one, and may lead to results which may be directly translated into actual procedure on an industrial scale.

In the discussion which followed the paper, it was pointed out that brewers had recognised the effect of hops, and that there had been a great reduction in the quantities used of recent years. Dr. L. T. Thorne, who has worked in this direction for some time, actually claimed that under certain conditions it had been shown that alcohol might aid digestion. The whole matter in view of the almost universal use of alcohol is one of great interest, and the ordinary individual will wait with some impatience for the final verdict of the chemist and physiologist on this matter.

School v. Factory.

The recent speech by Lord Haldane on commercial supremacy was partly concerned with the length of time spent at school by children in this country, and a comparison with those of the Continent.

Under present conditions a British workman finishes his education at thirteen, while in many parts of the Continent that training is now going on till sixteen, seventeen and eighteen. This extended education was not only concerned with general education, but in the chief point in the calling the workman would exercise in the future.

Referring to the latter part of this programme, it is open to doubt whether this can be so well taught as in the works itself. At the recent dinner of the Silk Association one speaker held that only when the hands came to work at an early age could they master the full secret of successful manipulation. It is quite possible that the same law may apply here as in the case of piano or violin playing.

This same view was presented in the House of Commons by one of the Labour Members. Speaking of the raising of the age of half-timers, he said, "People who wanted to learn cotton weaving successfully needed to learn while their fingers were still supple."

The matter is one which goes down to the root of the educational question.

It may be that considerations of this nature will ultimately determine the practical limit of school life, and that a fuller realisation of this important point may weigh heavily in the final standard set by our educational authorities.

THE INSTITUTE OF METALS.

March 17th and 18th, 1914. Annual General Meeting, London.

The following is a list of the Papers and Reports that are expected to be submitted on March 18th: First Report to the Beilby Research Committee, dealing with the solidification of metals from the liquid state, by C. H. Desch. "Bronze," by J. Dewrance. "Vanadium in Brass: The Effect of Vanadium on the Constitution of Brass containing 50 to 60% of Copper," by R. J. Dunn and O. F. Hudson.

"The Quantitative Effect of Rapid Cooling on Binary Alloys" (Second Paper), by G. H. Gulliver. "Crystal Protomorphs and Amorphous Metal," by Professor A. K. Huntington. First Report of the Nomenclature Committee. "The Influence of Nickel on some Copper-Aluminium Alloys," by Professor A. A. Read. "Muntz Metal: The Correlation of Composition, Structure, Heat Treatment, and Mechanical Properties, etc., etc.," by J. E. Stead and H. G. A. Stedman. "The Micro-Chemistry of Corrosion," Part II., by S. Whyte and C. H. Desch.

NOTES OF MEETINGS.

Institute of Chemistry.

March 2nd, Annual Meeting.

Chemical Society.

March 5th, 19th.

March 26th, at 4.30 p.m. Annual General Meeting.

Society of Chemical Industry.

LONDON SECTION—March 2nd.

(1) Messrs. A. Baker and J. Jennison, "The Bleaching of Chemical Pulp, and Suggestions for a Standard Method in Test Cases." (2) Professor W. R. Hodgkinson, "An Application of Calcium Carbide to the Formation of Alloys."

Society of Public Analysts.

March 4th. "Composition and Analysis of Compound Liquorice Powder," by A. E. Parkes and F. Major. "Composition of the Saline Matter adhering to certain wet Salted Skins," by M. C. Lamb. "Determination of Carbon Monoxide in Air," by F. S. Sinnatt and B. J. Cramer. "Simple Method for the Approximate Determination of 'Stump' (Wood) Turpentine in American Gum Turpentine," by L. Myddelton Nash. "Dried Carica Papaya Juice," by F. F. Shelley.

Royal Institution.

March 2nd, at 5 p.m. General Meeting.

March 7th, 14th, 21st, and 28th, at 3 p.m. Professor Sir J. J. Thomson, "Recent Discoveries in Physical Science."

Royal Photographic Society.

March 3rd. Technical Meeting.

March 10th. Ordinary Meeting.

Biochemical Society.

The Annual General Meeting will be held in the Botany Building, Imperial College of Science and Technology, on March 12th, at 5.30 p.m.

Society of Arts.

March 16th, 23rd, and 30th. Surface Combustion. Three Lectures by Prof. W. A. Bone.

March 31st. Oil Resources of the Empire, by Dr. Mollwo Perkin.

Institution of Civil Engineers.

March 3rd, 10th, 17th, 24th and 31st.

Institution of Mechanical Engineers.

March 20th. General Meeting.

A MOVE TOWARDS SCIENTIFIC SOCIALISM.

By PROFESSOR HENRY E. ARMSTRONG.

THE December number of Volume 50 of the *American Chemical Journal* contains a brief article, "In Conclusion," in which the editor, the distinguished chemist, Professor Ira Remsen, late President of the Johns Hopkins University, Baltimore, gives notice that the existence of the Journal as a separate publication is ended and that in future it will become a part of the Journal of the American Chemical Society. He explains how the Journal was founded in 1879 in consequence of a suggestion from Professor Dana (see Vol. 17, p. 470). In the meantime, he says, "the American Chemical Society has grown to great importance and is amply prepared to provide for the publication of all articles on chemical subjects likely to be prepared in this country. It is certain that if such a society had been in existence in 1878 the *American Chemical Journal* would not have been started. Taking everything into consideration, it now seems best for the editor to place the control of his Journal in the hands of this Society."

It appears that the Board of Directors and Council of the American Chemical Society had the wisdom to overrule a proposal made by the members of the organic division of the Society that Professor Remsen's Journal should be continued as the organic section of the Journal. Instead, the January number of the Journal of the Society has been issued with the addition to its former title of the words "with which has been incorporated the *American Chemical Journal* founded by Ira Remsen."

A more graceful and timely act of self-abnegation has seldom been performed. The thanks of chemists are due in full to Professor Remsen, in the first place, for the service he has so long rendered by the publication of his Journal—which certainly supplied a very real want in the earlier years of its existence; then for the very praiseworthy example which he has set.

The change has long been foreshadowed as desirable and doubtless Professor W. A. Noyes, the distinguished and versatile editor of the American Chemical Society's Journal, has played an important part in bringing the negotiations to a happy conclusion; for this and his many other services to the Journal he deserves our most cordial thanks.

It is quite clear that, in America, chemists are not only willing to work together but also show an amount of organising ability and of "organisability" which is lacking here.

Of late years, the Journal of their Society has been much developed and improved; we may hope that at no distant date it will be a complete record of the activity of chemists in the United States, either in consequence of the amalgamation of all other chemical journals with that of the Society or, if that be not possible, through the appearance of

sufficiently comprehensive abstracts of such work in the Journal of the Society. Apparently the *Journal of Physical Chemistry* has already been approached with a view to amalgamation.

The Society would render further service if it made the accounts of American work of greater length than and kept them in a section apart from the abstracts of "foreign" publications. The chief difficulty that will arise perhaps will be in connexion with the literature of bio-chemistry, so-called—a subject which is growing in importance; this is already far too voluminous. It would be most advantageous if this also were published under the auspices of the Society. The Society should be put in a position to deal with all the borderland literature and to take notice, in a systematic manner, of publications of the Experiment Stations, of the Carnegie Institute and of University colleges—in fact, of all literature of importance to chemists. The opportunity before the Society is a great one and it may be hoped that it will seize it before new competing organisations arise.

There is no doubt that, of late years, the *American Chemical Journal* has afforded undue licence of space to its contributors—except in the case of Professor Morse and his co-workers, who have carried modesty to an excess; the virtue is so rare in these days, however, that we can forgive them on account of the example they have provided. In this particular the American Society has set a praiseworthy example—Professor Noyes and his co-workers on the editing staff have obviously taken steps to discourage diffuse writing. They have not always been sufficiently alive perhaps to the need of translating authors' statements into English; in fact, they are a little peculiar themselves at times: take the following paragraph, at the end of the Report on the *Journal of Industrial Chemistry*, which is printed before the editor's name in the January number of the Society's Journal: "The editors are improving every effort to improve and strengthen the editorial section of the Industrial Journal . . . and in this as in all the features of its development need the co-operation of every member of the Society." No doubt they had in mind Dr. Watts' "How doth the little busy bee improve each shining hour."

ENGLISH CHEMICAL LITERATURE.

But charity begins at home. Fired by American example, cannot we now do something more to promote harmony where too much confusion reigns at present? The majority of our chemists publish accounts of their work in the *Journal of the Chemical Society* but the Society has never been sufficiently actuated by the spirit of patriotism to attempt to

give an *aperçu* of all the work done in our islands, let alone in other quarters of the Empire: it does not deign to consider the Royal Society's *Transactions*—literary sarcophagi, it is true, if not crematoria—and Colonial publications usually pass unnoticed. The Society needs an intelligence department. It also needs greatly the services of a literary editor to prevent defilement of the pages of the *Journal* by the execrable English and lack of literary style which too often pass muster.

Before it be all too late, we should seek to recover some appreciation of the difference between passive and active verbs, some idea of the right way to use prepositions. Formerly, it was impossible to speak of a substance "adding" this or that in the sense of combining with—now the solecism is of daily occurrence. For example, even so careful a writer as Professor Emil Fischer has acquired the bad habit: thus, in the last number of the *Berichte*, in one of his papers I find, "Das neue Produkt addiert sofort zwei Atome Brom." Picking up a number of the *Annalen* at random, my eye is at once caught by the opening lines of the first paper, "Das Hexabrom-pseudobromid . . . spaltet leicht ein Molekül Bromwasserstoff ab." I can imagine the shades of Liebig, Kolbe and Volhard being tormented by the reading of such passages from the *Annalen*. In days gone by, when in doubt how to express myself properly in English, I often used to ask: is this permissible in German? and thus got help. Alas! this is no longer possible. And yet we are told that German education is so superior to ours. The practice is now so widespread that it is often difficult, in cases in which the subject-matter is novel, to know whether horse or cart come first and what construction to place upon a passage. I have felt this difficulty over and over again recently in reading Willstätter's wonderful monograph on Chlorophyll: often I could not be sure what was implied until I had considered the context most carefully.

To resume my narrative, the management of our Chemical Society, of late years, has been so unimaginative that everything has been red-taped and much offence has been given by the inelastic administration of narrowly conceived rules. I speak from experience. My own feelings are so incensed that I would not touch its publication department with tongs: if no other means of publication were open to me, I would not publish at all. I also know that in the Royal Society the arbitrary enforcement of alterations has given rise to ill-feeling and not a few of the Fellows decline to submit their work to the Society, knowing that it will be subject to captious and often to inexperienced criticism; resenting the indignity of reference, some resort instead to the *Philosophical Magazine*, which is far better edited than most of the Societies' Journals.

If, therefore, we are to discuss any comprehensive and combined scheme of action, it must be primarily on the understanding that, whatever be the system provided, it shall be a tolerant system; science must stand for freedom of action, for freedom of expression. In at least one important case with which I am acquainted, intolerant criticism involved the

suppression of the scientific activity of a very original worker, who felt that unless allowed to say what he had to say in his own way he could not express himself at all.

But this is not to ask for licence or that we shall suffer all fools gladly: we must take power to deal with the fools—but gently. Thus I would ask less for direct literary correction than for literary advice, especially with regard to concise and logical statement of procedure and of results.

No difficulty should be placed in the way of conscientious expression of doubt, of conscientious objection to any particular system. In science, we need to be kept out of ruts, not to be forced into them; our points of view are sure to be changed as time goes on.

Gradually and by the force of constant good example we must be led to express ourselves more concisely. Much of the work that is placed on record is the work of prentice hands—who are but learning to work and educating themselves rather than adding to the sum of knowledge—so that it is rarely worth description at any length; at the same time, beginners need to be encouraged and trained into the right frame of mind and right ways of expression. I can look back upon the palmy days when the Chemical Society was served by that prince of editors, Henry Watts, who rendered inestimable service to young authors by his sagacious and kindly counsels; his hand was always that of the friend.

What we now most need is that authors should learn to express themselves concisely and to arrange their material logically—far too many of the papers published give satisfaction only to their authors: being "unreadable" they are unread; they count for little if anything in the progress of science.

A strong tolerant organisation could do much to improve the character of our scientific literature. To prevent it from abusing its power as well as of enabling it to offer advice and receive suggestions, however, the organisation should hold open meetings, quarterly at least, at which its actions could be challenged and rectified, if necessary, without exception being taken by the officials to any protests that were made—now the tendency is to treat such as personal insults.

But it is not only in order that we may avoid overlapping and therefore save in cost of production as well as the reader's time that I would advocate a fusion of all the separate interests now concerned in the preparation of abstracts of foreign publications. My main contention is that such action is of paramount importance on educational grounds, in order that we may have, in fact, may be forced to have, the whole of the subject-matter under our noses and may be able to read of things all and sundry if we so desire. By arranging the subject-matter in sections, each reader would be able to turn at will to the particular section which he desired to consult; but he would at least be under the temptation to turn over the pages of other sections and would be led insensibly to broaden his interests. While neces-

sarily specialists in our individual work, if we are to advance, we must seek to cultivate and maintain some breadth of mind.

Some years ago, when Professor W. A. Noyes came over here to advocate a scheme which would have led to the combination of American and English chemists in preparing abstracts in English of the chemical work of the world, most unfortunately the negotiations fell through, mainly in consequence of the unwillingness of the Society of Chemical Industry to co-operate. The feeling that by merging its individuality the Society would lose position—as the abstracts it publishes are its main asset—must still operate unless the Journal of the Society can be made a substantial publication independently of the abstracts.

A little wise direction, a little enterprise and this could be accomplished, I believe.

It is to be expected that there will soon be a material increase in the amount of original matter contributed to this Society, provided the management be considerate and tolerant, as it is quite clear that science is at last beginning to play a part in our industries. No one will wish that details of manufacture upon which success depends should be divulged but many problems invite discussion and it will be to the interest of the body corporate to discuss them. The fuel question, in all its details, is one that may be specifically mentioned as clamouring for consideration. It is only necessary to refer to the Journal of the Institute of Brewers as proof positive that it is within the power of a particular industry to debate many of its problems openly with great advantage; this Journal indeed is a model publication and the abstracts that appear in it are by far the best now published. On the other hand, gasworks throughout the country, with very few exceptions, are examples of the effect which neglect of scientific assistance can have in holding back an industry; had its problems been freely discussed—as they might have been, as it is one into which competition does not enter—the public would not have been subject, in the way they are at the present day, to the depreciation of their property, if not of health, by the supply of an article which the manufacturers, instead of seeking to improve its quality, have actually sought and obtained Parliamentary sanction in recent years to render more noxious in its use; some knowledge would have been gained of the processes underlying the industry and of its by-products. And there are many subjects which need full discussion: for example, the recent action taken by the gas companies to acquire the right to manufacture sulphuric acid and generally to compete with chemical manufacturers.

AN ENGLISH IMPERIAL CHEMICAL CLEARING HOUSE.

A much larger problem is opened up, however, as we inquire into the possibility of consolidating the interests of the various English organisations concerned with chemistry and its applications—the Chemical Society, the Society of Chemical Industry, the Society of Public Analysts, etc., etc.

Where there is a will there is a way: hitherto the will to co-operate has been wanting. Naturally enough we break up into more or less narrow cliques; but we are almost forced to do so by the illiberal and autocratic action which the party in power, in the organisation which happens to occupy the leading position, is prone to exercise. Indeed, one of the chief difficulties in effecting a sane organisation of our interests will arise from the fact that no one is prepared to trust a body like the Chemical Society with sole control of our interests: breadth of view and the Christian spirit have so obviously been lacking from its management. After all, the world is full of human nature and human nature is proverbially selfish and narrow, if not blind; at the same time it has corns and objects to their being trodden upon all too frequently. If we are ever to unite our scattered interests, if the movement our American cousins have so happily inaugurated is to be successful ultimately, it will only be because we have learnt to be tolerant. A red-tape system of regulations administered by narrow-minded officials will at once lead to revolt. Herein lies the value of the independent Journal and of a variety of organisations to the same end; we must not abandon these until we have a guarantee of sympathetic treatment.

Science is progressive: we cannot work to any rule absolute; our conclusions are always open to modification; we must be allowed to initiate and advocate changes. But the small mind of the official is ever the last to appreciate and tolerate originality and independence. Therefore we must not tolerate any hard-and-fast set of rules; there must be give and take. From this point of view the reference in the Report made to the American Chemical Society by Professor W. A. Noyes to the opposition (to the elision of the final *e* from certain words) "of a number of our contributors who have given us some of our most important papers" is most refreshing; obviously objections have not only been raised but actually listened to. The words *medicine*, *alkaline* and *urine*, for example, are to be spelt in future as Englishmen spell them. It is much to be hoped that the "e" may now be restored to *oxide* and *sulphid*, which are hideous abortions to our English eyes and especially to our English ears. The "e" in *medicine* and *urine* is of little consequence, however, as the "i" is shortened in pronouncing both words, though indispensable in *alkaline*; but the omission of the "e" from *oxide* ought to have been followed by the withdrawal of our ambassador.

"JOURNAL OF THE SOCIETY OF CHEMICAL INDUSTRY."

The activity of all our publishing bodies is exercised in one or other of two directions, if not in both: the publication of original matter and the preparation and publication of abstracts. Something, probably much, may be said on behalf of the independent control of original matter by the various interests but not a word can be urged in extenuation of the absurd system whereby various bodies duplicate the work of the Chemical Society in preparing abstracts;

these undoubtedly should all appear between the same covers.

In publishing a Journal of Industrial and Engineering Chemistry separately, the American Chemical Society has set an example which we may well consider. Last year the Journal contained 1,052 pages of reading matter and 604 pages of advertisement; of 850 articles, more than 300 were direct contributions by authors and 179 of these figure as original papers. The direction in which our Journal might be modified is clear. Reports such as the Chemical Society publishes with reference to pure chemistry might well be prepared and published at intervals, as opportunity offered—not annually. The admirable Hurter lecture given recently at Liverpool by Professor Haber is a brilliant example of what might be accomplished; each of its sections might well be expanded and made the subject of a comprehensive critical report. Special critical essays by competent writers would often be of great value. To effect the necessary changes, the Society will need to get rid of the narrow cliquism which is, in no small measure, a consequence of its democratic constitution; also to bring in intelligence and young blood; much of the palæontological *débris* which hampers its management must be cleared out.

But young blood alone will not suffice: with it must be associated courage and constructive ability and the spirit of enterprise—all these seem to be lacking. Over and over again complaint has been made to me by the younger chemists that their views are not sufficiently heard: but sad experience has shown me that when they have had the opportunity of expressing themselves, they have rarely risen to the occasion and that they are the last to profess tolerance; when I have reproached them with lack of courage, they have replied that, if they had spoken out, so and so would have resented their action and they would have suffered in consequence. There is much truth in this—but risks must be taken if work of consequence is to be done: some measure of patriotism must prevail. Our present condition of ineptitude is intolerable!

Hitherto, the Society of Chemical Industry has belied its name and has lazily frittered away its time reclining on paper pillows stuffed with materials derived from foreign sources: it has done next to nothing towards weaving its own bedclothes; the members have themselves contributed very little. The existence of the Society as an effective body will only be possible, if it now wake up and manufacture its own materials—materials of high average quality—industriously. It must have a forward policy and one worth working under.

GERMAN CHEMICAL LITERATURE.

Perhaps when we have followed American example and achieved some measure of success, Germany may follow suit. The German Chemical Society has counselled brevity of late years but, in the case of the abstracts it publishes, has carried this so far, by introducing all sorts of bewildering

abbreviations, that it is impossible to construe the articles with any degree of patience; they may satisfy limited German requirements but anyone accustomed to use either the American or English abstracts, which are far better on the average, will not regard them seriously. One remark by the way. Whatever the language, most of the abstracts now published fail to give sufficient information as to the contents of papers and are far too full of matter for which the original should be consulted; the title would be almost as useful as the abstract is in very many cases. As already pointed out, a praiseworthy example is to be found in the *Brewers' Institute Journal*: in this, in some cases, the abstract is nearly as long as the original.

Unfortunately, only papers of a certain type find favour with the authorities of the German society; consequently the Journal now affords a very incomplete picture of the advance of our science and the fellows are but poorly served.

Germany suffers from a plethora of private adventure publications; these doubtless find suffi-

Journal and Date of Foundation.	Year of foundation	1903	1908	1913
<i>Liebig's Annalen</i> (1832):				
No. of vols. per year ..	4	4	4	7
Price (per vol.) ..	—	6s.	6s.	6s.
<i>Zeitsch. physik. Chem.</i> (1888):				
No. of vols. ..	1	4	4	4
Price (per vol.) ..	—	17s.	17s.	19s.
<i>Zeitsch. physiol. Chem.</i> (1877):				
No. of vols. ..	1	3	4	6
Price (per vol.) ..	—	12s.	12s.	12s.
<i>Biochem. Zeitsch.</i> (1906):				
No. of vols. ..	1½	—	9	10
Price (per vol.) ..	14s.	—	14s.	14s.
<i>Pflüger's Archiv. f. Physiol.</i> (1868):				
No. of vols. ..	1	8	5	6
Price ..	—	Varies according to number of plates, diagrams, etc.		
<i>J. Biological Chem.</i> (1905):				
No. of vols. ..	1	—	1½	3
Price (per vol.) ..	\$3.25	—	—	\$3.25
<i>Zeitsch. angew. Chem.</i> (1888):				
No. of vols. ..	1	1	2	3 ¹
Price (per year) ..	—	20s.	30s.	36s.
<i>Zeitsch. anorg. Chem.</i> (1892):				
No. of vols. ..	2	4½	4½	6
Price (per vol.) ..	—	12s.	12s.	12s.
<i>Centr. f. Bakteriologie</i> :				
No. of vols. ..	—	5½	6	12
Price (per vol.) ..	—	15s.	15s.	15s.

¹ Changed from quarto to folio.

cient sale to justify their production, owing to the large number of libraries which are practically

forced to subscribe to them. Little discrimination seems to be exercised in choice of matter and diffuse writing is not only permitted but encouraged, in some cases, by the payment of authors! Moreover, no limit is put upon the number of volumes issued per year and subscribers are called upon to pay per volume or set of volumes.

So long as it was under Volhard's management, Liebig's *Annalen* were issued at the rate of four volumes per annum and the greatest care was exercised both as to the character and to the style of the papers printed; now apparently everything is accepted, and the papers are very diffuse; the change has been effected at the cost of the subscriber and not to his advantage.

The task before the German is, for the reasons stated, far more serious and difficult than our own; but it is all the more necessary, perhaps, that the work should be undertaken.

The table on p. 70, for which I am indebted to Mr. Clifford, librarian of the Chemical Society, is eminently instructive from this point of view, as a clear indication of the way in which the wind is blowing—towards extravagance and confusion.

A large proportion of the papers in the Journals in the table are obviously mere transcripts of laboratory

note-books and the work of beginners; many could be left unpublished without any danger to society.

It appears that 240 copies of Professor Remsen's Journal were sold to libraries and institutions and only 103 copies to individuals not members of the American Chemical Society; what number went to members of the Society is not stated—possibly not many. This gives an idea of the character of circulation such journals enjoy. Apparently the private subscriber to technical journals is a fast diminishing quantity; most of us who maintained a library of periodicals in our early days have ceased to do so, not only on account of the expense and the shelf-room required but particularly on account of the deterioration in quality such literature has suffered of late years. This is unfortunate, as it carries with it the decay of the reading habit and all that this involves.

In my early days I knew quite a number of well-read chemists. I rarely meet one now among the younger generation; in fact, the tit-bit habit is upon us everywhere and we tend more and more towards blind specialism.

Surely it is for the elders to take counsel together in the interests of the rising generation, remembering that they were once juniors and were helped forward in their early days.

COLLOIDAL CHEMISTRY IN 1913.

By EMIL HATSCHEK.

VIGOROUS activity in the whole field of colloidal chemistry and physics may again be said to have prevailed during the past year. It is perhaps only natural that certain subjects, such as indiarubber, should occupy in the periodical literature an amount of space more commensurate with their technical or commercial than with their scientific importance, but no important branch of the science has been neglected.

As regards theory, it is gratifying to record that success attended the enterprise of the Faraday Society in arranging an international discussion on a subject so eminently theoretical as "The Viscosity of Colloids," in the early part of the year. Dr. Wolfgang Ostwald and Professors Pauli, Henri, and Freundlich attended from abroad and read papers on various aspects of the subject, a paper on its mathematical theory being contributed by the present writer. The papers and the discussion¹ brought out both the importance of viscosity measurements as a means of following changes of state in colloidal solutions, and also the difficulties of a rational interpretation of the results—due principally to the fact that only the weight, and not the active volume of disperse phase, can be directly determined.

Pending a solution of this difficulty the diagnostic value of viscosity measurements remains,

and is dealt with by various writers. A. Schwarz² advocates their use in celluloid industry, and gives a number of data showing the connection between degree of nitration, bleaching, etc., as well as of the age of the sols and viscosity. A. Baker³ publishes a very large series of viscosity determinations on sols of various nitrocelluloses in a number of solvents and expresses the viscosity-concentration function by an empirical logarithmic formula. J. G. Fol⁴ advocates viscosity measurements on rubber soils and to some extent follows Schidrowitz and Goldsbrough, but suggests a different procedure for expressing the value of the rubber from the viscosity-concentration curve. While the former obtain by extrapolation what they call the "viscosity figure" of rubber itself, Fol wants to use the area of a certain portion of the viscosity diagram as the "viscosity figure." Whatever empirical value either of these methods may possess, they seem both equally devoid of any physical or analytical meaning.

As regards other physical properties of sols, results likely to be of considerable importance for the theory of disperse systems generally are given in a paper by E. Navassart⁵ on the optical activity of tannin solutions. He was led to undertake this

¹ *Trans. Faraday Soc.*, July, 1913, pp. 29—108.

² *Koll.-Zeitschr.*, XI., 32.

³ *Trans. Chem. Soc.*, Vol. 103, 1653.

⁴ *Koll.-Zeitschr.*, XII., 131.

⁵ *Koll.-Zeitschr.*, XII., 97.

investigation by the serious discrepancies in published values of the specific rotation of this substance. The result is, briefly, that in water the specific rotation is not a constant at all, but a function of the concentration which decreases greatly with increasing concentration. Thus $[\alpha]_D^{20}$ was 49.86° at 20% and 89.75° at 0.08% concentration. In organic solvents, as alcohol, acetone and glacial acetic acid, the specific rotation is much smaller and also much less variable with concentration. The specific rotation in various solvents varies in the same order as the molecular weight of tannin determined in those solvents.

Inorganic sols have not received much attention and two publications only deserve notice. H. Morris-Airey and S. H. Long⁶ describe the preparation of metallic sols by disintegration in a high frequency alternating arc, the necessary current being taken from a Poulsen arc as used in wireless telegraphy. Sols of a large number of metals were obtained, among them both red and blue gold sols. The blue sol is stated to show cathodic migration—an entirely anomalous behaviour for a metallic sol, all of which migrate to the anode. It is reasonable to suggest that the disperse phase may have been largely oxide, as a considerable amount of oxidation is known to occur in this method even with the noble metals. A. Gutbier and E. Sauer⁷ obtain sols of lead dioxide by the hydrolysis of ammonium hexachloroplumbate $(\text{NH}_4)_2(\text{PbCl}_6)$ as a clear brown liquid with negatively charged disperse phase. The decomposition of the complex ion $(\text{PbCl}_6)^-$ with sol formation is interesting.

Adsorption experiments are published by several investigators. A. Rakowski⁸ extends his studies on adsorption by starch to mixed solutions of alkalis and neutral salts. In the case of the fixed alkalis and of barium hydrate adsorption is increased by the neutral salt, while in the case of ammonia—which is only slightly adsorbed when alone—the addition of a neutral salt is practically without effect. In a further paper he analyses⁹ the results on the assumption that “amylates,” *i.e.*, actual compounds of the starch and bases, are formed by applying the equations of hydrolysis, but without any very definite results. Two very important papers by H. Freundlich and H. Schucht also deal with various aspects of adsorption. The first¹⁰ gives the results of a very exhaustive investigation on the electrolyte coagulation of a mercuric sulphide sol, and at the same time of the adsorption of the cation. The object of these experiments was to test Freundlich's well-known theory of electrolyte coagulation, and the results are in very good agreement with it; the adsorption isotherm applies to the various cations, the amounts adsorbed when coagulation takes place fall on the isotherms, and the amounts adsorbed at this point are roughly equivalent.

The second¹¹ paper deals with the decrease or reversal of adsorption which takes place when the surface of the adsorbent is gradually reduced. The latter is again mercuric sulphide precipitated from the sol mentioned above by the necessary amount of a dyestuff (Neufuchsin), so that the liquid remains colourless. The precipitate gradually becomes more and more coarsely crystalline and dye goes back into solution. The velocity of this change is investigated and the authors find that the relation between time and amount redissolved can be expressed by an autocatalytic equation of the first or second order. The authors then discuss a number of processes showing a somewhat similar course, and sketch an explanation of the Liesegang phenomenon on the same basis, which will be again referred to below. T. Oryng¹² continues his investigations (begun with potassium permanganate) on adsorption accompanied by chemical action and finds that this occurs with charcoal in bichromate solution. The adsorption of potassium ion is almost independent of concentration and reaches equilibrium in a few minutes, while that of $\text{Cr}_2\text{O}_7^{2-}$ continues after many hours, indicating chemical reaction with the adsorbent. In a second paper¹³ the same author deals with the subject of negative adsorption. He finds that this occurs unquestionably with charcoal in a solution of bichromate with the addition of sodium hydroxide, and that the increase in concentration of bichromate ion is surprisingly large and, as should be the case, almost directly proportional to the amount of charcoal used in a given volume of the mixed solution.

Among papers dealing with special colloids those on rubber, as usually, preponderate, and only a few can be referred to here. D. Spence and J. Young¹⁴ resume the discussion on the vulcanisation problem. They investigate indiarubber, gutta-percha and balata, and find that the course of (hot) vulcanisation, as expressed by the time-combined sulphur curve, is identical for all three hydrocarbons. They also study the connexion between temperature and velocity of combination and show that it agrees well with the temperature coefficient of chemical reactions in general. They emphatically restate their view that vulcanisation is “a catalytic chemical reaction which follows the general laws applying to such.” F. Kirchof¹⁵ studies the oxidation of rubber and concludes that the first step is the formation of peroxides, which cause secondary oxidation and in raw rubber produce tackiness. Oxidation of vulcanised rubber takes a substantially similar course and eventually leads to the formation of sulphuric acid. The sulphur content of the oxidised rubbers on treatment with alkali is found to be reduced to two-thirds of the original value, and the author sees herein confirmation of the “thiozon” (S_3) theory of vulcanisation. A. von Rossem¹⁶

⁶ *Proc. University of Durham Phil. Soc.*, V., Part 2.

⁷ *Koll.-Zeitschr.*, X11., 171.

⁸ *Koll.-Zeitschr.*, X11., 128.

⁹ *Koll.-Zeitschr.*, X11., 177.

¹⁰ *Zeitschr. phys. Chem.*, LXXXV., 641.

¹¹ *Zeitschr. phys. Chem.*, LXXXV., 660.

¹² *Koll.-Zeitschr.*, X11., 9.

¹³ *Koll.-Zeitschr.*, X11., 14.

¹⁴ *Koll.-Zeitschr.*, X11., 265.

¹⁵ *Koll.-Zeitschr.*, X11., 49.

¹⁶ *Koll.-Zeitschr.*, X11., 78.

reviews the work of Gorter,¹⁷ who suggests that rubber (like tin) exists in two modifications, ordinary rubber being metastable, and tacky rubber stable, at low temperatures. On this view it should be possible to "infect" sound rubber with tacky rubber. Experiments to this effect failed with solid rubber, but Gorter claims to have obtained progressive reduction of viscosity in a mixture of sound rubber sol with one whose viscosity had been previously reduced by exposure to light, although the mixture was kept under red glass. Von Rossem fails to obtain this result, but confirms the loss of viscosity of benzene-rubber sols on exposure to daylight; after thirty days the viscosity had fallen to about one quarter, while controls kept in the dark had lost very little. The same result is obtained by G. Bernstein,¹⁸ who deals with the depolymerisation of solid rubber by the agencies of (1) heat, (2) mechanical treatment, and (3) light, as shown by comparing the viscosities of sols made from rubber so treated with those of sols from the untreated material. He finds that, after complete depolymerisation by any one of the above agencies, products are obtained which all show the same viscosity, and concludes that complete depolymerisation of various kinds of rubber leads to a material having the same state of aggregation in all cases. He also finds that a mixture of rubber and sulphur is vulcanised, *i.e.*, the sulphur combines, under the influence of ultra-violet light. In a further paper¹⁹ he discusses the effect of various vulcanising agencies and concludes that they lead to the formation of the insoluble (polymerised?) modification of sulphur. G. Stafford Whitby²⁰ deals with the spontaneous coagulation of Hevea latex and finds four agents necessary to account for the various changes: a coagulating ferment, an oxydase, an anaerobic and an aerobic decomposition. The first brings about coagulation, which is retarded by dilution. Anaerobic decomposition proceeds in the portion less accessible to air. The oxydase may produce discoloration according to the velocity of the other changes and the acidity. Aerobic decomposition occurs in the last stage of the process, more especially in the surface, where it produces alkalinity. The four agents must be different and independent from each other.

As regards proteins, the investigations of H. Chick and C. J. Martin, originally published in the *Biochemical Journal*, have been translated into German and appear in connected form in the *Kolloidchemische Beihefte* (Vol. 5). The same authors²¹ deal with the "salting-out of proteins" as instanced by the precipitation of egg-albumin by ammonium sulphate. They find that the first effect of the salt is to withdraw water from the albumin aggregates, with the formation of two phases, one rich and one poor in albumin, both of which, however, contain all three constituents; that the ratio of

the volumes of the two phases varies with the temperature, and that the former ratio as well as the proportions of water, salt and protein are very sensitive to the hydrogen ion concentration of the system. They also advance a theory of the influence of hydrogen ion, supported by experiments. A paper by H. Chick²² deals with the solution and precipitation of euglobulin, with particular reference to the electrical factors, but cannot be conveniently summarised here. W. W. Lepeschkin²³ discusses the structure and properties of protoplasm from various points of view suggested by modern colloidal chemistry. Among other subjects he deals with destruction of the structure, *i.e.*, "death" through mechanical treatment, which is accelerated by H⁺ and retarded by OH⁻, in accordance with the generally alkaline reaction of living protoplasm; where this reaction is faint, or even neutral (spirogyra) the sensitiveness to deformation is particularly marked. After a careful discussion he sums up against the existence of a lipid membrane on protoplasm.

In addition to the paper by Navassart, two others dealing with optical properties of colloids deserve mention. G. S. Walpole²⁴ investigates the refractive index of gelatin sols and gels and finds it, in both states, practically a linear function of the concentration. It is unaffected by the addition of electrolytes, and the temperature-index curve shows no discontinuity about the setting point. The results are directly contradictory of those previously published by Walter Frei.²⁵ H. Ambronn²⁶ deals with the double refraction of nitrocelluloses. Cotton shows double refraction, which is positive referred to the longitudinal axis of the fibre. On nitration the double refraction (as found by Naegeli) decreases with increasing N-content, becomes zero and eventually negative. This change is quite gradual. Investigation of the degree of nitration shows it generally uniform over the length of individual fibres, but different in fibres of the same batch. The author recommends polarimetric examination as a valuable control in the manufacture of nitrocellulose—a suggestion which is probably not entirely novel.

New methods for the ultra-microscopic examination of liquids have been designed by both the pioneers of ultra-microscopy. R. Zsigmondy²⁷ has a new apparatus built for him by Winkel of Göttingen, in which both the illuminating system and the microscope objective are of the (water) immersion type. Observation is carried out in a drop of liquid hanging on both, and the usual cell is dispensed with as well as the "precision slit" of the original instrument. The new ultra-microscope resolves particles not visible in the slit instrument. H. Siedentopf²⁸ publishes details of an improved method of using the cardioid condenser, in which

¹⁷ *Mededeelingen over Rubber*, Buitenzorg, 1911.

¹⁸ *Koll.-Zeitschr.*, XII., 193.

¹⁹ *Koll.-Zeitschr.*, XII., 273.

²⁰ *Koll.-Zeitschr.*, XII., 147.

²¹ *Biochem. Journal*, VII., 380.

²² *Biochem. Journal*, VII., 318.

²³ *Koll.-Zeitschr.*, XIII., 181.

²⁴ *Koll.-Zeitschr.*, XIII., 241.

²⁵ *Koll.-Zeitschr.*, VI., 192 (1910).

²⁶ *Koll.-Zeitschr.*, XIII., 200.

²⁷ *R. 85, Versammlung deutscher Naturforscher*, Vienna.

²⁸ *Koll.-Zeitschr.*, XII., 68.

the cell is also dispensed with. The liquid to be examined is placed on a slide of the proper thickness, and the microscope objective is immersed directly in the drop without the interposition of a cover glass. A suitable objective, for use with a compensating eyepiece, has been designed by Zeiss & Co.

The purely systematic side of colloidal chemistry gives rise to an interesting controversy between R. Zsigmondy and W. Ostwald, on the latter's classification of emulsoids. As is well known, he divides them into suspensoids and emulsoids; the latter, according to him, are systems of two liquid phases and a characteristic of many of them is that they (*e.g.*, soap sols on addition of salt, or gelatin on addition of neutral salts or alcohol) can be segregated into two liquid layers. Zsigmondy²⁹ describes a number of experiments on typical *suspensoids*, in which he obtains what he considers similar results that ought to be impossible according to Ostwald. Z. adds alcohol to the hydrosols of gold or arsenic sulphides and by addition of ether obtains segregation into two layers, one containing the whole of the colloid, while the other is clear and colourless. Ostwald³⁰ very conclusively points out that this is in no way analogous to the "salting out" of emulsoids, since in Zsigmondy's experiments the colloid plays no part at all; separation occurs just the same without it and is, in fact, only the well-known segregation of ternary mixtures.

The Liesegang phenomenon does not figure very largely in the periodical literature, the protagonists in this field having apparently been less active. R. E. Liesegang³¹ attacks the experiment by which the present writer attempted to disprove the Ostwald supersaturation theory; this contro-

versy is likely to be settled shortly by fresh evidence. W. P. Dreaper³² obtains stratifications and also macroscopic crystals, *e.g.*, of lead chloride, by allowing reactions to take place in capillaries without using a gel at all. H. Freundlich and H. Schucht (see note 11) suggest a new theory of the stratifications: that they are due to electrolyte coagulation of the reaction product which is autocatalytically accelerated by the latter.

On the other hand, the phenomenon has given rise to two important books, in which a surprising number of instances of stratified deposits, zone formation, etc., in nature are explained on the basis of the Liesegang rings, *i.e.*, by periodic precipitation in a gel. These are R. E. Liesegang, "Geologische Diffusionen" (Leipzig, Theodor Steinkopff) and E. Kuester, "Zonenbildung in kolloiden Medien"—"Zone formation in colloidal media, being a contribution to the mechanics of anatomical development in plants" (Jena, Gustav Fischer). It is not often that a single laboratory experiment is so fruitful in furnishing the key to so many and diversified phenomena, the accepted explanations of which have, in many cases, been highly artificial. Other works published during the year are: Sven Oden "Der kolloide Schwefel" (Upsala, F. Berling), a handsome volume dealing with the author's extremely complete investigations on colloidal sulphur, and a small introductory text-book by the present writer.

In conclusion it is of interest to record that colloidal chemistry has received official recognition (as far as the writer is aware, this is the first case of a public collection) by the Science Museum, which has placed on exhibition a series of typical sols and gels. The classification adopted is that of W. Ostwald.

²⁹ *Koll.-Zeitschr.*, XIII., 105.

³⁰ *Koll.-Zeitschr.*, XIII., 170.

³¹ *Koll.-Zeitschr.*, XII., 74.

³² *Journal Soc. Chem. Ind.*, XXXII., 679.

THE CHEMIST IN HIS RELATION TO MANUFACTURING INDUSTRY.

By JOHN B. C. KERSHAW, F.I.C.

THE question of the training and position of the chemists who are engaged in the manufacturing industries of this country has been discussed for so many years, and by so many different persons, that it may seem difficult at the present moment to say anything useful or new on the subject. But a paragraph in the Editorial Notes on electro-chemical engineering, which appeared in the December issue of THE CHEMICAL WORLD, has stimulated the writer to place on record a few of the opinions he has formed in the course of a career which has been more varied, and therefore more educational in its influence, than that which falls to the lot of the majority of chemists. Hitherto, the question of the training and status of chemists has been discussed almost entirely by the professors who train them, or by the classes who employ them; and it is but rarely that the voice or opinions of the unfortunate

individual whose virtues and failings they are discussing are allowed to be heard in the dispute. It is with the purpose, therefore, of filling in to some extent this neglected part of the picture that the writer has ventured to intrude his personality into the discussion, and to set on paper a few facts and opinions gathered in the course of a somewhat wandering chemical career.

Since the paragraph referred to above may be regarded as the text that has inspired this article, it may be given here in full:—

"It will be remembered that the recently appointed Secretary to the London University Appointments Board has deplored the fact that the best chemists do not enter the industrial world. They remain in the colleges to teach. This hermit-like action may be regarded as an error in policy from the general point of view of the position of the

chemist, and the influence he exerts on industry in this country.

"Under the best conditions such a man may remain in, possibly, the institution in which he received his training in college chemistry, to pass this on to a succeeding generation of chemists, and to engage in academic research."

This is undoubtedly true, and the explanation of this "hermit-like action" is that the status and rewards offered to the chemist in a professorial career are at present much greater than those offered in the manufacturing or industrial world. The clever and more ambitious men who have finished their college course and taken their degree of B.Sc. or M.Sc., therefore, elect to take the badly-paid posts of demonstrators or assistants in the colleges or universities where they were trained, in the hope that after years of waiting they may obtain preferment to the higher rank of professor in some home or colonial college, and thus obtain a footing on the ladder which may lead eventually to the Chair of Chemistry at one of the greater universities of our country. The opportunities and facilities for engaging in research work during this period of waiting, and of obtaining the coveted Fellowship of the Royal Society, is also another incentive to this "hermit-like action" on the part of the students of chemistry who have just completed their college course of training.

Contrast with this the position and prospects of the chemist who enters some works, after obtaining his Science degree. His commencing salary as a works chemist may be higher than that offered to the lower ranks of the professorial staff of the college or university where he was trained. In nine cases out of ten, however, he will be compelled to occupy a position subordinate both to the general manager and to the works engineer, while his status and pay, even after years of hard ungrudging work, devoted to the interests of his employers, will never equal those of the more successful of his friends who have elected to remain within the walls of their Alma Mater. There are, the writer admits, exceptions, and in some cases the chemist is given the position and status he ought to have in our manufacturing industries, but this is only where the Board of Directors is permeated with the scientific spirit, or where the general manager of the concern is a man of scientific training. The majority of English industrial concerns are still controlled by boards of directors, more distinguished for their business and financial ability than for their knowledge of science, and by general managers whose chief claim to the post is that they were born and bred in the industry and obtained all their training inside the works where they are employed, or in one similar to it. Under these conditions of service, there is little need to be surprised that the chemist occupies a quite subordinate position in the scheme of management, and that the chief aim of the manager and engineer is to keep him busily engaged upon the routine work of the laboratory.

In short, *our colleges and universities offer a career to the cleverer and more ambitious men, and our works and industries do not.* This is the simple

reason why so many of the best-trained chemists elect to remain in subordinate positions in our colleges and universities, or to take the less promising and lower paid posts of science instructors in our public and secondary schools. The fault is not on the side of the chemist, or on the side of those who trained him, but lies at the door of those who control our manufacturing industries. They have demanded not well-trained chemists, *but testing machines and laboratory hacks*, and our technical institutes and secondary schools have supplied their demand with zeal and efficiency. In any of our large towns to-day, one can meet with dozens of such men holding positions as works-chemists, at salaries of 30s. to 50s. per week, content to remain in these positions for the remainder of their working days. A works-chemist enjoying a salary of £300 or more per annum is, in fact, a *rara-avis* in these northern climes.

The remedy for this state of things is obviously to raise the status and pay of the chemist who enters the manufacturing and industrial world, and to render his prospects as regards position and emoluments as attractive as those of the other branch of the profession. Unfortunately, although progress is occurring in this direction, it can be but slow. The change means obtaining the services of more highly educated men on the Boards of Directors, or boards of management, of all manufactures and industries in which chemical processes or changes are involved. There is still in this country, in spite of Lord Haldane's missionary efforts and zeal in the cause of science, an absurd lack of scientific knowledge in capitalist and business circles, and our industries are still controlled largely by men whose chief qualifications are their business aptitude—and their intimate knowledge of the practical side of the manufacture.

The writer knows only one chemical company in England in which science has been adequately recognised in the appointments to the Board of Directors, and although it is always unsafe to generalise from inadequate data, it is a curious fact that this company should be one of the most successful and progressive in the whole country.

In Germany, it is quite customary to find men of high scientific attainments as Managing Directors of great industrial concerns, and in time no doubt our insular prejudice in favour of the man with a merely business training for such positions will be thrown overboard. When this time has arrived, and the career open to the university trained man is as unbounded in its possibilities as that which lies before his *confrère* in Germany, the present lament about the "hermit-like action" of the best chemists will cease, and there will be no lack of scientific knowledge and ability displayed in the control or management of our manufacturing industries. The demand will create the supply, as it has done in the lower ranks of laboratory machines, and the man whose college scientific training has been completed by a further period of training in the offices and works will restore to some extent the fortunes of our declining chemical industries.

CHEMICAL INDUSTRIES.

A Monthly Review of the Progress of Technical Chemistry.

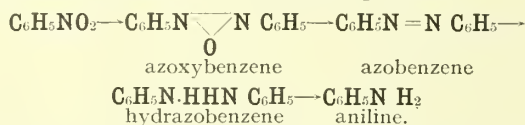
CATHODIC REDUCTION OF ORGANIC NITRO-COMPOUNDS.

By ERIC K. RIDEAL, PH.D., B.A. (CANTAB.).

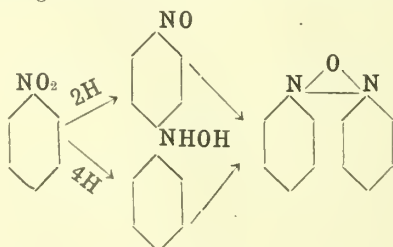
In an article on the electro-saturation of fatty compounds with hydrogen (August, 1913) some experiments on the reduction of the iodine value of fats by means of electrolysis were noted and compared with the purely chemical methods; it was then pointed out that up to the present time electrolytic processes had not offered any practical solution to this branch of chemical industry. The case is somewhat different in the cathodic reduction of organic nitro-bodies where many reduction derivatives of these compounds are prepared solely by this means.

All substances which can be reduced chemically may also be electrochemically reduced at the cathode of an electrolytic cell, provided that the right conditions are obtained; furthermore in the preparation of organic compounds one great advantage of electrochemical processes over its chemical rivals depends on the fact that the presence of the oxidised products of the reducing agents, *e.g.*, zinc oxide, is avoided. These occasionally react with the organic body, and in any case have to be removed.

According to Haber, who has investigated the process in great detail, cathodic reduction is controlled by the cathodic potential and by that alone; consequently alterations in the nature of the solvent, the current density or the electrode material are only important if they affect this value. It may be stated generally that cathodic reduction may consist in the withdrawal of oxygen from the compound that acts as a depolariser as well as the possible addition of hydrogen; this is well shown when the simplest aromatic nitro-compound, nitrobenzene, is subjected to electrolytic reduction in an alcoholic alkaline electrolyte. The following is the general scheme of the reduction process:—

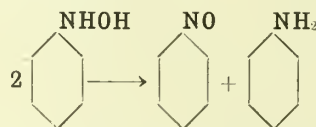


The formation of azoxybenzene has been explained by Haber and Bamberger by the intermediate formation of nitrosobenzene and phenylhydroxylamine, which interact according to the following scheme:—



The unstable nitrosobenzene is a much more powerful depolariser than nitrobenzene, the cathodic potential of a polished platinum electrode when immersed in an alcoholic alkaline electrolyte being reduced from -0.78 volts in

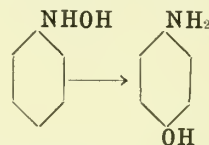
nitrobenzene to -0.48 volts in nitrosobenzene. The yield of azoxybenzene is not good since the phenylhydroxylamine under the action of the alkali is converted into nitrosobenzene and aniline:—



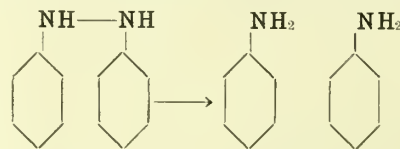
Azoxybenzene is not directly reduced to azobenzene as one might expect, but according to Haber preliminary reduction as far as hydrazobenzene takes place and this in turn is oxidised by the nitro and nitrosobenzene present to the azo compound.

In alcoholic sulphuric acid solutions the reduction proceeds somewhat differently; the potential of the cathode in acid nitrobenzene solutions takes on a higher value, the depolarising power being much less than in alkaline solutions (the cathode potential being $+0.04$ volts instead of -0.78 volts as in the alkaline solution).

The main products of reduction are p-aminophenol and aniline; derivatives of the former body are technically important in the manufacture of photographic developers, while aniline and its homologues are the basis of the "aniline" dye industry. p-Aminophenol is produced by the action of the acid solution on the phenylhydroxylamine which is also formed in small quantities:—



Hydrazobenzene is similarly converted into benzidine—



As has been already stated, on raising the cathode potential we increase the reducing power of the electric current. One of the simplest methods in practice for bringing this about is to substitute for platinum, the usual electrode material, some other metal possessing a high "overpotential" value for hydrogen. Lead is one of the most suitable metals in this respect; as an example of its suitability in this connection an electrolysis of nitrotoluene in alcoholic sulphuric acid solution resulted in a 90% yield of toluidine at a lead cathode.

The following metals, in the order of the magnitudes of their overpotential values, have been used in electrolytic reduction cells: Mercury, lead, cadmium, tin, nickel, copper, zinc, iron, brass, and platinum.

The addition of the salts of tin, lead, mercury or iron, or even of metals in the form of a finely-divided powder, to the catholyte will bring about a similar increase in the reducing power of the current. The mechanism of this

action is at present under dispute, it being maintained by some authorities that the metal *per se* functions as a reducer, while others are of the opinion that the effectiveness of the process is due to the increased catalytic power of a freshly deposited metallic film on the electrode.

The following is one of many reactions that may be brought about by this means: In an alcoholic sulphuric acid electrolyte *o*-nitrotoluene can, at a platinum electrode, in the presence of divided copper, be reduced to *o*-toluidine with a yield of 97% and a current efficiency of no less than 95%.

Aliphatic nitro-bodies may be electrolytically reduced in alcoholic sulphuric acid solutions at nickel cathodes to hydroxylamines provided that the temperature is not allowed to rise above 15° C. ; above 70° C. a nearly quantitative yield of amines may be obtained. According to D.R.P. 116942 alkaline solutions may be substituted for the acid catholyte, provided that tin cathodes are used.

Among the more important nitro-derivatives which are at any rate partly manufactured by electrolytic methods may be mentioned: From nitrobenzene—p-aminophenol, hydrazobenzene, and some aniline.

Among the dyes we find :—

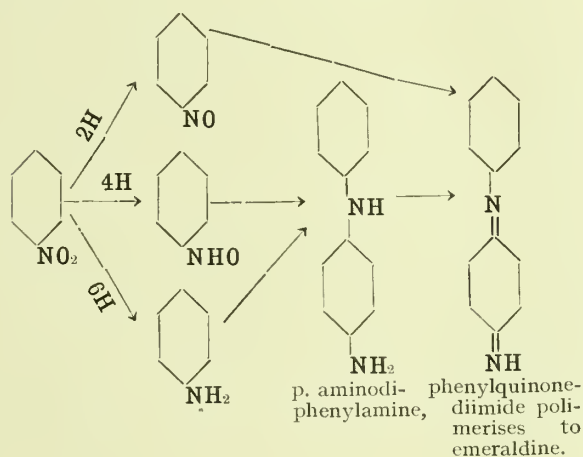
Naphthazine or alizarine black, from the reduction of dihydroxyanthraquinone and dinitronaphthaline in sulphuric acid solution.

Sun yellow (p-azoxystilbene).

A blue mordant dye of unknown composition, resulting from the reduction of dinitroanthraquinone in fuming sulphuric acid solution.

Emeraldine, from the reduction of nitrobenzene in sodium bisulphate solution.

According to Nover (*Ber.* 40, 288) the mechanism is as follows :—



According to D.R.P. 116336, a whole series of induline dyes may be prepared by the electrolysis of a mixture of a hydrochloride of an aromatic amine and a nitrocompound, *e.g.*—

Aniline.	P-nitrophenol.	Blue.
Aniline.	O-nitrophenol.	Bronze.
M-nitraniline.	P-nitrophenol.	Grey-blue.
M-nitraniline.	O-nitrophenol.	Bronze.
<i>a</i> -nitronaphthaline.	„	Violet.
<i>aa</i> -nitronaphthol.	„	Dark violet.
Nitroalizarine.	„	Chocolate.
4-nitraniline, 3-sulphonic acid	„	Red violet.

NOTES ON RECENT THEORY AND PRACTICE.

By HERBERT H. HODGSON, M.A., B.Sc., PH.D.

MANY forms of superstition which on the surface are apparently absurd, may on closer investigation contain some groundwork of scientific truth. It is on the latter assumption that E. G. Bryant (*Chem. News*, October, 1913) has taken up the study of a widespread belief which is prevalent in many parts of the world, and especially in tropical regions, that moonlight exerts a deleterious influence upon fish and to a lesser degree on meat intended for food. If two slices, cut from the same fish were hung, one in the direct light, the other in the polarised beam, the latter invariably began "to decompose before the former, though the temperature of the polarised beam was several degrees lower than the direct light." In other experiments with meat, jam, cane-sugar solution, and several kinds of seeds, no decisive results have been as yet obtained, although any indications seemed always in favour of the polarised light.

L. J. Curtman and M. Mosher have made an interesting study of the delicacy possessed by certain of the confirmatory tests for tin (*Jour. Amer. Chem. Soc.*, 35, No. 4). The well-known test of reducing the tin in hydrochloric acid solution by means of iron (generally in the form of an iron nail) and subsequently treating the stannous chloride formed with mercuric chloride, was proposed by A. H. Allen in 1872, and, although in general use, nothing very definite appears to be known as yet concerning the conditions under which this test may be relied upon to give constant results. Students having frequently failed to report the metal led the authors to undertake a comprehensive survey of this important subject. The conclusions arrived at were:—that certain nails were unsuitable because of the irregularity of their action; that in a total volume of 5 c.c. with $1\frac{1}{2}$ in. cut nail the best conditions are: time of heating, 3 minutes in boiling water-bath, acidity 2.5 c.c. concentrated hydrochloric acid. Under these conditions the smallest amount of tin that can be detected either alone or in the presence of 250 mgs. of antimony is 0.2 mg. in a volume of 5 c.c., although it is imperative to run a blank when the quantity of tin present is small. Instead of the iron nail, some analysts prefer to reduce the tin to the metallic state by means of zinc in acid solution, and then to re-dissolve the tin in hydrochloric acid with subsequent addition of mercuric chloride. This latter modification has recently been examined by Noyes and Bray (*J. Amer. Chem. Soc.*, 29, 181), who found it to possess a delicacy of 0.5 mg., a result confirmed by Curtman and Mosher. An investigation of the conditions under which the ammonium molybdate test for stannous tin might be applicable to stannic solutions after reduction by zinc showed that with a total acidity of 2.5 c.c. of concentrated hydrochloric acid in a volume of 10 c.c., the test is delicate to 0.01 mg. tin in the absence of antimony. The acid should be added in two portions, the first to aid in the reduction of the tin by the zinc, and the second to re-dissolve the spongy tin which separates out. By this means rapid solution of the tin is secured, whereas if the total quantity of acid be added at the outset it was found that the tin did not readily go into solution on further heating. In the presence of 250 mgs. of antimony, the test may be used to detect 0.05 mg. of tin, while the presence of 5 mgs. antimony is without influence on the delicacy of the test.

An extensive study of aminosulphonic acid and its derivatives has been made by Hofmann (*Ber.*, 45, 1394, 1731). The acid, which crystallises pure and anhydrous from a not too concentrated solution of hydroxylamine hydrochloride which has been saturated with sulphur dioxide, is suggested as a standard for acidimetry, since the acid is non-hygroscopic and can be accurately weighed. It may be titrated in N/10 strength against N/10 KOH with phenol phthalein or methyl orange, against N/10 NH₃ with rosolic acid, and against N/10 Ba(OH)₂ with phenol phthalein, in every case giving accurate acid values. The N/10 solution is hydrolysed by 90 minutes' boiling to the extent of 38.5%, while after 11 hours the amount has risen to 88%. At 40° C. the hydrolysis is very slow, and at 15° C. not recognisable at the end of a week. A very important point is that since hydrolysis gives rise to ammonium hydrogen sulphate it does not affect the acid value, although, owing to the presence of ammonium, phenol phthalein cannot be used as an indicator. From another standpoint, aminosulphonic acid is an excellent reagent for the preparation of aryl sulphuric acids and phenol sulphonic acids. The author has prepared an interesting series of salts in which the hydrogen of the —NH₂ group is more or less replaced by mercury, silver, or gold, e.g., Hg: N . SO₂OK, Ag. HN . SO₂ . OK, and Au₂(N . SO₂ . OK)₃.

The mechanism of the acid dye bath is the subject of an important paper by M. Fort (*J. Soc. Dyers and Col.*, 1913, 29, 269—277). The view held by the author regarding the specific preparing action of acid dye baths on wool is, that the latent basicity of the wool is developed by the acid and that the combination of the dyestuff with the fibre depends on the increase of the number of basic groups thus made available by the hydrolytic action of the acid. The amino groups of the wool must be supposed to combine with acids or colour-acids to form additive salts, analogous to the salts of aniline. The reactions taking place in the acid dye bath are expressed thus: (1) $\text{H}_2\text{SO}_4 + \text{Na, colour-acid} \rightleftharpoons \text{Na}_2\text{SO}_4 + \text{free colour-acid}$. On the fibre: (2) $\text{Wool} + \text{water} \rightleftharpoons \text{wool-hydrate}$. (3) $\text{Wool-hydrate} + \text{H}_2\text{SO}_4 \rightleftharpoons \text{wool-basic-hydrate} - \text{H}_2\text{SO}_4$. (4) $\text{Wool-basic-hydrate, H}_2\text{SO}_4 + \text{colour-acid} \rightleftharpoons \text{H}_2\text{SO}_4 + \text{wool-basic-hydrate-colour-acid}$.

Apart from colour or its absence, there appear to be two types of acid as regards behaviour towards wool: (1) A class which rapidly hydrolyses the wool complex, thereby increasing the basic groups available, such acids being usually removable by exhaustive extraction with water; these acids are the ordinary "assistant" acids, and also picric acid which happens to be coloured. (2) Acids possessing a weak hydrolysing action on the wool substance and only slightly capable of combining directly, but readily replacing the acid groups of the first class in combination with the developed basic groups and not readily extracted by water. This second class comprises the colour-acids and certain others which do not happen to be coloured. By comparing the absorption of sulphuric acid alone and in presence of the colour-acid, the author found that definite molecular ratios exist between the two types of acid in relation to the wool and that, for instance, 2 mols. of sulphuric acid are replaced by 1 mol. of Bordeaux colour-acid in forming additive salts with wool.

A perennial research topic is the investigation of the colours formed by heating cobalt nitrate with various oxides, as in qualitative analysis, and Hedvall (*Ber.*, 45, 2095), working on the subject, has prepared Rinnmann's green in hexagonal crystals of some size by heating zinc

oxide with cobalt carbonate to 1,100°, using KCl as flux. The cobalt is in bivalent form and the CoO : ZnO ratio is 1 : 4.8 or perhaps 1 : 5. The chief object of such experiments, however, is to solve the problem of whether the various coloured products are chemical individuals or merely solid solutions, and Hedvall's results leave matters much where they were. Progress, however, in this direction appears to have been made by Burgstaller (*Chem. Zentr.*, 1912, 2, 1523), who, noting the fact that the colours in question are blue, red, or green, considers that in the case of blue and red it is a question of solid solutions exhibiting the colours of ordinary cobalt solutions. With the green of zinc oxide, however, blue is on a substratum of yellow, and although zinc oxide is white at ordinary temperatures, yet when heated it becomes yellow, the reversal into white again on cooling being prevented by the cobalt oxide present. If this theory be true, it would seem possible to obtain a blue colour with zinc under proper conditions.

An interesting derivative of hydrazoic acid with cyanogen has recently been prepared by Darzens (*Compt. Rend.*, 154, 1232), by acting upon cyanogen bromide with sodium nitride, whereby a carbon pernitride or cyanogen trinitride (or hydrazoate) $\text{N} \equiv \text{CN}_3$ is formed. CN_4 is a colourless oil, crystallising in needles which melt at 36° C., and is soluble in most organic solvents. It is slightly volatile *in vacuo*, begins to decompose at 70° C., and explodes at 170° C. with great violence. Although exceedingly sensitive to shock, it may be preserved for a long time when perfectly pure. CN_4 readily undergoes polymerisation, forming a solid insoluble in ether and non-explosive to shock. The aqueous solution of CN_4 readily hydrolyses to the acid $\text{N}_3\text{.COOH}$, which in turn decomposes into HN_3 and CO_2 .

When magnesium boride is acted upon by acids, a gas consisting of hydrogen boride and hydrogen is evolved, and the isolation of the hydrogen boride has so far defied chemical effort. Stock and Massenez (*Ber.*, 45, 3539) have now in part solved the problem, and their results come as somewhat of a surprise, since the simplest gas evolved is H_{10}B_4 , and this is accompanied by another whose formula is probably H_{12}B_6 , in addition to others apparently formed by the decomposition of the latter. The difficulties of previous experimenters have arisen from the small quantities of the borides formed, their great instability, especially in the presence of water, the problem of separating the different borides formed in the reaction, and the unavoidable presence of hydrogen silicides from the silicides in the magnesium boride used. The present authors prepare the hydrogen borides by allowing the finely powdered magnesium boride to fall slowly into acid and condensing the evolved gas by liquid air, the total yield being under the most favourable circumstances 1.2 c.c. per litre of evolved hydrogen. The liquid obtained was fractionated, and only after great difficulties were sufficient of the above compounds obtained for study. H_{10}B_4 boils at 16° C. and H_{12}B_6 at a higher temperature, while both ignite in contact with air and decompose in water.

A series of yellow wool dyestuffs stated to exceed tartrazine in greenness of shade and fastness to light have been obtained by the Chem. Fabr. Griesheim Elektron (*Eng. Pat.* 10,549, *J. S. C. I.*, September, 1913), by diazotising adjacent m-xyldine or its 4- or 5- sulphonic acid and coupling with an arylpyrazolone of the benzene series, or a carboxylic or sulphonic acid thereof, such as 1-p-sulphophenyl-5-pyrazolone-3-carboxylic acid. Dyestuffs of still more greenish tint are obtained by using 1-p-sulpho-o-tolyl-5-pyrazolone-3-carboxylic acid, whilst

a dyestuff said to surpass quinoline yellow in greenness is obtained by combining diazotised adjacent m-xylydine-4-sulphonic acid with m-sulpho-o-chlorophenyl-5-pyrazolone-3-carboxylic acid. The sulphonic acids of adjacent m-xylydine are obtained by treating the base with monohydrate or fuming sulphuric acid.

Formic acid is recommended as a solvent by O. Aschan (*Chem. Zeit.*, 1913, 37, 1117—1118), since a product of 95% concentration can now be obtained at a price about one-half that of glacial acetic acid. Its solvent power in many cases exceeds that of acetic acid, in addition to its superiority with regard to differences of solubility in the hot and in the cold. Against these must be placed the ease with which it undergoes oxidation and with which it esterifies alcohols. An interesting reaction is its reduction by sodium iodide with liberation of iodine, but not by potassium iodide. Inorganic salts are generally less soluble in formic acid than in water, but certain organic compounds such as terephthalic acid, indigo, uric acid, and alizarin, which are practically insoluble in the usual solvents, dissolve to a not inconsiderable extent even in cold formic acid, while in the boiling acid the solubilities of the compounds mentioned are 3.02, 0.16, 0.16, and 0.82 gms. respectively per 100 c.c. of solution.

Light waves of length $< 350 \mu$ are injurious to the eye and epidermis, so that a glass for absorbing ultra-violet rays would be extremely valuable. Such a glass is now claimed to be made by a process patented by the Sanoskop Glass Co. (Fr. Pat. 456,294, April 3rd, 1913). It has been found that while most heavy metals absorb the ultra-violet rays, they so modify the chemical and mechanical properties of glass as to render it useless. The rare earths, however, e.g., cerium, thorium, etc., are found to be efficient in this respect, and the heavy metals are only added as decolourising or colouring materials.

An important communication from an economic standpoint has recently been made by S. H. Collins and A. A. Hall (*J. S. C. I.*, October, 1913), who, having made a systematic study of beets grown in the northern counties, find, contrary to general opinion, that sugar beet with a fairly high percentage of sugar may be grown there.

Determinations of the Acidity of Fruit Juices.—Edgar G. Miller, Jr. In line with Dr. Gies' proposal of the use of diluted vinegar and various "food-acid" media as dentifrices, I have determined the acidity of some common fruit juices as a preliminary to the selection of the most suitable ones for prophylactic application to the teeth. The appended data for acidity represent, in most cases, the averages of triplicate results, in c.c. of $n/5$ sodium hydroxide solution (phenolphthalein) per 10 c.c. of juice: Apple, 3.5; apricot, 3.8; asparagus, 0.9; banana, 2.6; beet (red), 1.1; cantaloupe, 0.6; carrot, 0.8; cauliflower, 1.9; celery, 0.8; cherry, 7.6; cocoanut milk, 0.4; cranberry, 19.6; cucumber, 1.0; currant, 20.4; gooseberry, 16.2; grape (white), 4.5; grape fruit, 10.3; horse radish, 9.2; lemon, 53.7; orange, 6.7; parsnip, 2.1; peach, 6.4; pear, 3.2; pineapple, 7.5; plum, 4.8; radish, 0.6; rhubarb, 11.1; strawberry, 9.3; tomato, 4.2; turnip, 0.6; vinegar, 26.1; watermelon, 0.6.—*Biochemical Bulletin*, 1913, 11, 554.

CURRENT LEGAL TOPICS.

Chemical Patent Cases, 1913.

BY WILLIAM JAGO.

PROBABLY the most important chemical patent action brought during the past year was that of *Joseph Crosfield and Sons, Ltd. v. Techno-Chemical Laboratories, Ltd.* The subject-matter of the patent was the hydrogenation and consequent hardening of fatty bodies by treatment with hydrogen in the presence of nickel, adapted to act as a catalyser. This action has already been discussed in these columns (October, 1913). Among other chemical cases the following may be mentioned:—

New Inverted Incandescent Gas Lamp Co., Ltd. v. M. Howlett & Co.—In this case the plaintiffs were the owners of a patent for "Improvements in or relating to gas-burners." They used for incandescence gas lighting a bunsen burner, with a mantle of the usual head-downwards type, and provided an "insulator," preferably made of bad heat-conducting material, with a deflecting cone on such isolator, the isolator terminating in a burner head projecting into the incandescence mantle. The object of the invention was to prevent the striking back of the lighted gas. The defendants supplied inverted gas burners, constructed in the main of glazed pottery ware, and having an air shield in order to prevent heated fumes from entering the burner. The action was one for infringement of the patent, and resolved itself into what the learned judge termed "an exceedingly small point." One of the essential parts of the plaintiffs' combination is a deflector near the nozzle of an inverted burner, which deflects the heat and the flame tending to strike back. This being so, have the defendants got either that deflector or something which only colourably differs from that deflector? The judge arrived at the conclusion that the element in the patented combination was absent in the defendants' apparatus, and therefore that there had been no infringement. The action failed, and judgment was given for the defendants with costs. The case was carried to the Court of Appeal, which confirmed the decision of the Court below. The decision turns on the fact that the defendants were held not to have taken one of the essential parts of the invention, and therefore not to have infringed. The defendants were entitled to reduce the heating of the gases by the use of an isolator of any thickness, and that one of the essential parts of the patented invention was the deflector, and this was wanting in the defendants' apparatus.

Another somewhat interesting case was that of *Margreth v. Acetylite Lamp Co.* The action was one for infringement of a patent for "Improvements in acetylene storm lamps." The patentee claimed "an acetylene storm lamp wherein gas is produced at a high pressure in an acetylene generator and is caused

PROFESSOR R. W. WOOD, of Johns Hopkins University, Baltimore, lectured before the Physical Society on the 27th ult., delivering the first Guthrie Lecture. The subject chosen was "Radiation of Gas Molecules excited by Light."

to issue from a burner at a velocity exceeding that of the gas ignition, so that the actual flame will be situated at a distance from the burner head." On behalf of the plaintiffs it was argued that acetylene tends to polymerise, and that, when burned in the ordinary manner direct from a jet, solid matters are produced which block up the burner. By using the acetylene under pressure the velocity of the issuing gas is such that the flame only begins about $\frac{1}{4}$ in. from the burner. In reply for the defendants it was said that the law as to the pressure necessary in order to separate the flame from the jet was well known. Further, in the "Wells Light," vaporised oil was burned in exactly the same manner as was proposed for acetylene, the two burners being identical. Could there be a good patent for taking the "Wells Light" and using acetylene with it? In giving his decision the learned judge said, first, that the invention was sufficiently described, as it enabled anyone who understands the subject to construct the apparatus. The next point, which is more important, was whether there is what amounts to an invention in the subject-matter of the patent. It had been said that the common knowledge at the time of the invention was such that the patentee was not entitled to claim a monopoly. With this the judge did not agree, and pointed out that, although acetylene had been used for a long time, it was generally employed in something like a flare lamp. The judge next dealt with the contention that the "Wells Light" anticipated the invention. In this connection he remarked that it is said that, because a similar kind of lamp for purposes of burning either gas or heated vapour had been constructed, therefore there was no invention in applying this to acetylene, and concluded his judgment in the following words: "It seems to me that is not quite so. Nobody could say at the time the patentee filed his specification whether or not acetylene could be used in the way described by the patentee in the specification; it might be said that very likely it could be, but nobody had tried it, and nobody had provided the lamp for which there was a demand, as is shown by the fact that when the plaintiffs put it on the market they succeeded in effecting very large sales of their lamp. I think, therefore, that the patent is a good one, that there was invention required for the purpose of applying acetylene gas to be used in a flare lamp of this character, and therefore the plaintiffs succeed in their action."

This case is both interesting and instructive, as showing the modicum of invention necessary in order at present to support an invention. Chemists will need no prompting from the present writer to form their own opinions in this matter. Given first a lamp that burns vaporised oil under pressure so as to yield a flame that shall be separated by an interval from the jet, the chemist can judge how much invention is involved in burning acetylene in a similar manner from a similar lamp. It is interesting to look at some of the *dicta* in the older cases. Thus in *Losh v. Hague*, the judge stated that: "The law on the subject is this: that you cannot have a patent for applying a well-known thing, that might

be applied to 50,000 different purposes, for applying it to an operation which is exactly analogous to what was done before. Suppose a man invents a pair of scissors to cut cloth with, if the scissors were never invented before he could take out a patent for it. If another man found he could cut silk with them, why should he take out a patent for that?" In the present case the well-known thing is the Wells flare lamp for burning vaporised oil; the patent is for the application of the same lamp to the burning of acetylene, another combustible gaseous hydrocarbon, and for this purpose closely analogous to vaporised oil. The views now generally taken by the Courts are more in favour of the patentee than was formerly the case. Where a new article has very large sales, and thus shows that it fulfils a demand, a mere scintilla of invention suffices.

Knight v. Argylls, Ltd., was an engineering and not a chemical case; it is, however, mentioned here because of some observations by one of the Lords Justices as to the comparative value of the evidence of experts and practical workmen in relation to the question of whether a specification is misleading. The learned judge set up as the standard by which to decide whether a specification is misleading, the question—Is it intelligible to the ordinary workman conversant with the subject-matter? The experts, albeit of unimpeachable eminence, only said that an ordinary workman ought to be able to understand the specification and drawings taken together, and so to make the engine. But before a working engine could be made according to the patentee's specification, some working drawings were necessary, and their annexed drawings would be relied on till their untrustworthiness was found out. The ordinary workman had therefore to take the drawings first and the specification afterwards, and the kind of puzzle produced by the drawings was not one which reference to the specification would promptly solve. This is where the standard of the ordinary workman comes in, and it is obvious that, in weighing experts against mechanics, much depends upon the impression produced by the latter on the judge with regard to intelligence, practical competence and honesty of the effort to understand. After all, such men speak to what is; the experts to what ought to be.

The Marine Torch Co. v. Holmes Marine Life Protection Association was an interesting case, but disclosed nothing particularly novel in the application of patent law. The patent which was the subject of the action was for an improved marine torch, for which was claimed: "The combination with a shell, having a chamber charged with carbide of calcium or equivalent material adapted to produce illuminating gas in the presence of water, and having a second chamber for air or gas to render the shell buoyant, of a burner communicating with said carbide chamber, and a pilot light comprising a vessel charged with phosphide of calcium or equivalent material, said vessel having an opening through which the gas evolved may escape, and said opening being adjacent to said burner for the purpose set forth." The action was one for infringement, and the defence was partly want of novelty. It was

shown that, prior to the patent, a light for the purpose had been produced by means of calcium phosphide. Further, there was an earlier patent for the use of calcium carbide in conjunction with calcium phosphide, the two substances being contained in separate chambers, but so arranged that the gases produced by the action of water on each were described as "mingling as they issue." The point was whether an earlier invention, in which a

mixture of acetylene and phosphuretted hydrogen was produced, which mixture became spontaneously inflamed on meeting the air, was a sufficient anticipation to render invalid the subsequent patent, in which the two gases were kept separate and the phosphine acted simply as a pilot light for the acetylene. It was held that the difference between the two was sufficient to maintain the validity of the latter patent, which was therefore upheld.

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

CHAPTER III.

BEFORE proceeding to a discussion of the newer applications of catalysis to inorganic processes, reference must be made to several other industries which, although well known, possess great interest when viewed from our present standpoint. The most important—and space permits us to deal only with these—are the Deacon process for chlorine, the Hargreaves-Robinson process for salt-cake, and the Claus-Chance process for sulphur recovery from alkali waste.

I. DEACON PROCESS.

For close upon three-quarters of a century, it has been known that a mixture of hydrochloric acid gas and oxygen, when strongly heated and particularly when in contact with porous substances, undergoes partial decomposition, with the formation of water and the liberation of chlorine (Oxland, 1845).



Under the stated conditions, though, the yield is so small as to render the process impracticable; but it was soon discovered that by the employment of some substance capable of acting as an oxygen carrier, the decomposition could be greatly assisted. Of such substances the salts of copper have been found most useful, especially the chloride, which was first employed by Vogel in 1855 in a method involving successive combination with hydrochloric acid, and decomposition by oxygen. Like that of Oxland's, however, this process proved unsatisfactory, though for a different reason. It remained for Deacon and Hurter in 1868 to establish a successful chlorine manufacture on these lines by the employment as catalyst of pumice impregnated with cupric chloride, thereby combining the efficiency, so far as the yield was concerned, of Vogel's method with the continuity of Oxland's.

In the course of a series of investigations it was established by Hurter that the cheapest and most efficient catalyst available for the purpose was cupric chloride, and, strangely enough, this contact material still holds the field against all others that

have been proposed since that time. This result was deduced from a diagram showing the affinity of all likely elements for oxygen, chlorine and hydrogen—the diagram being obtained by plotting the heats of combination of these compounds against the atomic weight of the element concerned—from which it could be seen at a glance that no other metal than copper forms two oxides and two chlorides in which the combination is of so loose a character. The diagram (see *Jour. Soc. Chem. Ind.*, 1883, 2, 106) is mentioned here, since it furnishes one of the few cases in which the likeliest catalyst has been selected by a preliminary theoretic inquiry.

In the early stages of the development of the process, the working results proved somewhat unsatisfactory. For some cause, as then unexplained, the catalyst was quickly rendered inactive when "roaster gas" was employed, the latter, of course, having as impurity the products of combustion from the open furnaces in which the second stage of the salt-cake process is effected. The poisonous effect of impurities upon the catalyst had not been realised at that time, so that the employment of "roaster gas" had to be abandoned and recourse made to "pan gas," i.e., the gas evolved from the closed pans during the first stage of the decomposition of salt by sulphuric acid. In thus evading the first difficulty, however, another difficulty was raised; for whilst the efficient working of the process demands a continuously-supplied mixture of hydrochloric acid gas and air of definite composition, the evolution of gas from a salt-cake pan is such a diminishing and variable quantity that this condition cannot be fulfilled. By employing two or more salt-cake pans and suitably mixing the gases, the drawback was removed to some extent, but the compromise did not tend to efficiency.

The disadvantages attendant upon the use of "roaster gas" have been overcome largely by the researches of Hasenclever (1876). This investigator attributed the rapid deterioration of the catalyst to the presence of sulphur trioxide in the "roaster gas," whereby a coating of sulphate was formed on the copper chloride employed; and proposed to eliminate this injurious action by first absorbing

the gases in water and then treating the resulting impure acid with hot sulphuric acid and air, by which means a mixture of pure gaseous hydrochloric acid with the requisite amount of air could be obtained. Other remedies have been suggested, but Hasenclever's process (1883) is admittedly the most thorough.

As would be expected, sulphur trioxide is not the only undesirable impurity in the "roaster gas." Oxide of arsenic produces arsenate of copper, which is even less reactive than the sulphate. The presence of carbon dioxide, too, introduces difficulties, for it present as a diluent of Deacon chlorine, it militates against the production of strong bleaching powder, a serious objection when it is remembered that Deacon chlorine is largely intended for the "bleach" industry. This latter difficulty has been surmounted, however, by improvements in construction of the apparatus whereby leakage is diminished.

Another impurity which exerts a deleterious influence is sulphur dioxide, for in the decomposes this is converted into sulphuric acid. Kolb (1891) provides for the removal of both the dioxide and trioxide of sulphur by passing the "roaster gas" over lumps of salt maintained at about 450°C ., as in Hargreaves' process (see below). Both acid gases are absorbed, and by interaction with the salt, generate a little more hydrochloric acid, which passes along with the unchanged hydrochloric acid of the "roaster gas." According to Gaskell (1893), the same effect is obtained by adding to the contact mass such substances as have a greater affinity for sulphur dioxide and trioxide than copper, e.g., calcium or magnesium chlorides.

Water also acts detrimentally, so that it is necessary to cool the gases down to about 40°C ., and dry them with sulphuric acid before they are allowed to enter the decomposer.

It is now recognised that cupric chloride is one of the most sensitive of catalysts to "poisonous" substances. On account, therefore, of the small traces of impurities, such as the above-mentioned arsenic compounds, which it is impossible to remove, as well as by reason of a gradual volatilisation of the copper salt, it is found necessary to renew the catalytic material at regular intervals.

This is effected in a satisfactory manner by the type of decomposer shown in Fig. 3, comprising an upright iron cylinder A, within which a cylindrical ring of contact material B is supported by iron shutters C. The annular space between the shutters is divided into six compartments, each of which is emptied in succession every fortnight. The contact mass, wholly renewed in this way every three months, consists of broken brick which has been soaked in a solution of cupric chloride, and contains when dry from 0.6 to 0.7% metallic copper. Entering by the pipe D on the circumference of the cylinder, the gases pass through the contact mass into the inner space and are led away by the pipe E.

The regulation of the temperature of the reaction in the decomposer is one of the primary considerations of the process. The most suitable temperature appears to be at $450\text{--}460^{\circ}\text{C}$.; above this, volati-

lisation becomes excessive, whilst below it, the yield is much diminished.

At the temperature of the decomposer, by no means all of the hydrochloric acid is converted into chlorine. Under the best practical conditions, only about two-thirds of this decomposition is effected, and the undecomposed acid has therefore to be recovered and applied to other purposes. Even then, however, a much greater percentage of the hydrochloric acid is utilised than in any process employing either natural or recovered manganese dioxide.

The sensitiveness of cupric chloride has naturally led investigators to seek other contact substances for the production of chlorine from gaseous hydrochloric acid. Ferric chloride was proposed by Thibierge (1855), platinised asbestos by Weldon (1871), chromic oxide by Hargreaves and Robinson (1872), pumice impregnated with nickel chloride by Mond (1886), a mixture of magnesium and

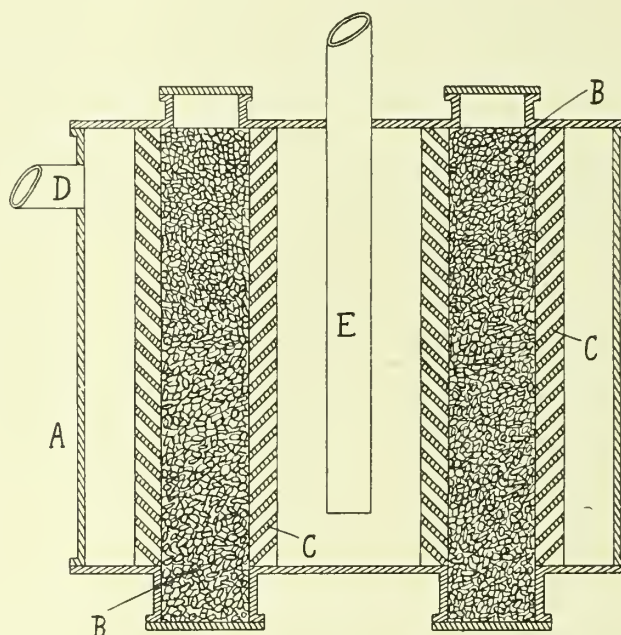
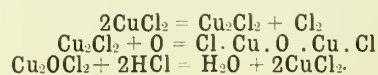


FIG. 3.—TYPE OF DECOMPOSER.

manganese chlorides with magnesium sulphate by de Wilde and Reyckler (1889), the chlorides of the rare earths by Ditz and Margosches (1904), and the double compounds or mixtures of cupric chloride with other chlorides by Dieffenbach (1908); but the application of none of these materials, so far as is known, has emerged from the experimental stage. From this incomplete list, however, it will be seen how numerous and varied are the catalysts for the interaction between air and hydrochloric acid gas.

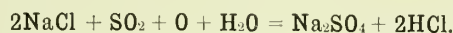
The mechanism of the reaction is usually explained on the lines of the intermediate formation of an oxychloride of copper, $\text{CuO} \cdot \text{CuCl}_2$. The following then comprises the cycle of reactions:—



Recently, however, Levi (1905, etc.) has advanced the theory that the catalytic activity of cupric chloride and its congeners is attributable to their hydro-avidity, *i.e.*, to the temporary formation of hydrates; for in the system $2\text{HCl} + \text{O}$, the tendency is towards the formation of water, and this would naturally be favoured by the presence of any substance capable of absorbing water. The usual catalysts of this process are certainly of this type; but, on the other hand, it is found that substances, such as calcium chloride, possessing marked hydro-affinity, exert little or no catalytic action. The results of Levi's experiments, moreover, it may be argued, can be explained just as well by the older hypothesis set out above.

II. HARGREAVES-ROBINSON PROCESS.

The direct process for the manufacture of salt-cake, first established on a successful practical basis by Hargreaves and Robinson in 1870, is deserving of mention in view of its later developments. Originally the process involved no catalyst, but consisted simply of the passage of pyrites gases over suitably-prepared salt at $500\text{--}550^\circ \text{C}$. in a series of chambers, giving rise to the following reaction:—



In 1886 they suggested increasing the speed of the reaction by the addition of a little ferric oxide to the salt; and again, in 1907, acquired the French rights for a process in which the reaction is promoted by the use of copper and iron salts. Other salts and oxides were suggested, but these latter appear to have the greatest influence. The superiority of copper oxide over iron oxide, it should be noticed, had already been pointed out by Krutwig and Dernoncourt in 1897, and by Conroy in 1902.

To take advantage of the catalytic activity of the copper and iron oxides, the salt is moistened, prior to moulding, with a solution of copper or iron sulphate or both, the content varying between 0.1 and 1.0%. The upper limit is only possible when the resulting salt-cake is intended for the Leblanc soda process, for there a little impurity has no effect; but where a purer material is required, as in the case of salt-cake for use in glass works, only a very small amount of the catalyst may be added. The addition of these materials not only increases the velocity of the interaction, but also diminishes the temperature of decomposition.

III. CLAUS-CHANCE PROCESS.

At one time, the greatest source of inconvenience to the manufacturer of alkali by the Leblanc process was attached to the disposal of the "tank-waste," *i.e.*, the insoluble residue, chiefly calcium sulphide, which remains after lixiviation of the "black ash," on account both of the space it took up and the annoyance its smell occasioned to the neighbourhood surrounding the works.

Several attempts were made to work up this

by-product, all of which proved unsuccessful, until in 1887 the firm of Chance Bros., after the expenditure of much time and money, succeeded in devising a process for the recovery of most of the contained sulphur at a price permitting competition with Sicilian brimstone. Incidentally, the achievement was a fortunate one for the Leblanc process, since it has enabled the latter to compete with its younger and more vigorous rival, the Solvay ammonia-soda process.

The method is based upon that patented in 1837 by Gossage (who lost his fortune in futile endeavours to establish it on a commercial footing), and consists in decomposing the calcium sulphide of the "tank-waste" by lime-kiln gases, followed by the incomplete combustion of the sulphuretted hydrogen thus obtained.

The main difficulties of Gossage's process were concerned with the generation of carbon dioxide and sulphuretted hydrogen in a sufficient degree of concentration. When attacking the problem later, Chance had not the first of these difficulties to contend with, for the production of air containing a large percentage of sulphur dioxide had already been worked out in connection with the manufacture of ammonia-soda, resulting in the introduction of Mond kilns which produce gas containing over 30% carbon dioxide by volume, the remainder being practically pure nitrogen. The second difficulty was finally overcome by utilising the fact that if such gas, rich in carbon dioxide, be passed into a series of chambers containing moist tank-waste, the carbon dioxide first reacts with the calcium sulphide to liberate sulphuretted hydrogen, which can then be brought into contact with fresh calcium sulphide in another chamber, where it is quickly absorbed to form calcium sulpho-hydrate,



the accompanying nitrogen, meanwhile, being allowed to escape from the first chamber. If now, more carbon dioxide is admitted in sufficient quantity just to decompose the sulpho-hydrate, a highly-concentrated stream of sulphuretted hydrogen will be evolved,



In practice, the chambers are so inter-connected as to be capable of arrangement in any required order to constitute the series. As a result, all the carbon dioxide of the incoming mixture is entirely replaced by sulphuretted hydrogen, while most of the accompanying nitrogen is effectually eliminated. It may be mentioned that the resulting desulphurised residue is quite unobjectionable.

The sulphuretted hydrogen thus obtained is next treated with a view to the recovery of its sulphur by a process patented by Claus in 1883—originally intended, however, for other application—in which the gas, after admixture with air to obtain the desired combining proportions, is passed through a hot layer of ferric oxide.

In the usual construction of apparatus, the Claus kiln, as it is called, comprises a cylinder

provided internally with a grating upon which rests a layer of broken firebrick, with a further layer of bog-iron ore superimposed. The combustible mixture, usually about 4 vols. of air to 5 vols. 38% sulphuretted hydrogen, enters at the top, passes through the porous layers, where it is burnt to sulphur vapour and steam with but little sulphur dioxide and sulphuretted hydrogen as impurity, and is drawn from the bottom into a series of condensing chambers, where part of the sulphur vapour condenses to liquid sulphur and the remainder as flowers of sulphur, along with the condensed steam.

The reaction is exothermic, so that no external heating is necessary. To start the reaction, a few shovelfuls of red-hot coal are thrown on to the oxide; whilst the temperature is regulated by controlling the speed of the gas.

During the process the ferric oxide becomes transformed into pyrites, but the pyrites so formed has some peculiar property attached to it which ordinary pyrites does not possess, for the latter is quite useless as a catalyst.

When once the necessary temperature has been reached, the reaction is found to proceed fairly satisfactorily with other contact material, such as broken

brick, though the working temperature then becomes somewhat higher than when ferric oxide only is employed. For starting the reaction, however, ferric oxide or similar contact material must be employed; hence the two layers in the Claus kiln. Recently it has been found that the temperature can be still further reduced by using "Weldon mud," the insoluble manganites of manganese and calcium, which are its principal constituents, serving as excellent catalysts. "Weldon mud," moreover, possesses the advantage of being able to oxidise fully the hydrogen of gases which are poor in sulphuretted hydrogen, and because of this, it too is often employed in the upper parts of the kilns. Bauxite is another material which is being used as a substitute for oxide of iron, and according to all reports, based on continued practical tests, it has proved an efficient catalyst for this process.

As mentioned when dealing with the Contact process for sulphuric acid, the catalytic activity of ferric oxide is to be attributed to the readiness of its transformation into some lower oxide when an oxidisable compound is present and its subsequent easy re-oxidation by atmospheric air.

(To be continued.)

NOTES ON CHEMICAL ENGINEERING.

By J. W. HINCHLEY, A.R.S.M., WH.Sc.

CHAPTER VI. (continued).

IN band conveyors for heavy materials the edges of the belt are turned up to form a trough by means of supporting guide rollers; the belts are much stronger and the fittings more substantial. The guide rollers and brackets for supporting them are usually made as shown in Fig. 67. The rollers are of equal diameter, the axes of the outer rollers being inclined to produce the troughing. The best inclination to the horizontal of these "troughing idlers" is probably 20 degs. for general work, although shallower and deeper troughing is common. In addition to troughing rollers, small guide rollers may be used at long intervals where any tendency for the band to move sideways needs checking. The best bands consist of several layers of stout canvas treated with and covered with rubber. The thickness of the rubber covering is made greatest where wear and tear is most severe, and the upper surface is often provided in the middle with a thickness of solid rubber of over $\frac{3}{4}$ in. tapering to the edges to about $\frac{3}{8}$ in. thick. The life of the bands is much affected by chemical influences and moisture; every care should be taken to prevent the exposure of the canvas, either by wear or by surface cracking of the rubber. Canvas belts treated with a mixture of balata and guttapercha are used for the lighter kinds of work, and woven wire belts for immersion in liquids.

The speed of the belts of heavy band conveyors

varies from 150 ft. to 400 ft. per minute, and depends mainly on the size of the material. For general work a speed of 250 ft. per minute is satisfactory, but with finely divided material a higher speed may be used with increased economy.

The driving pulleys should have a diameter not

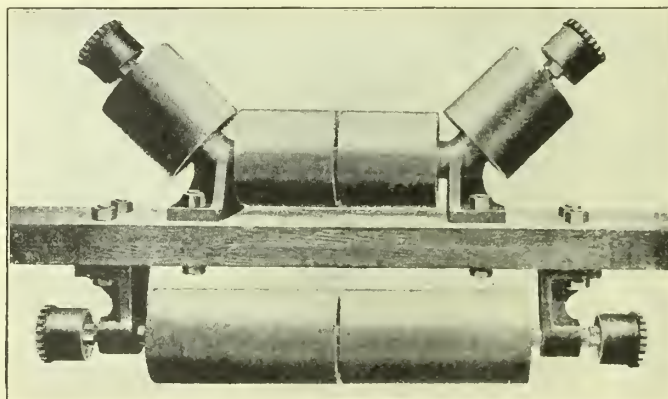


FIG. 67.—SUPPORTING GUIDE ROLLERS.

less than forty times the thickness of the belt at its thickest part, and in all cases greater than the width of the belt used. The faces of the driving pulleys should be slightly rounded and from 1 to 2 ins. wider than the belt.

The loading of band conveyors requires careful

treatment, and the shoot should be curved near the band and provided with an adjustment so that the discharge from the shoot is only slightly inclined to the horizontal and the velocity of the material is as nearly as possible equal to that of the band. Neglect of this precaution with heavy materials produces excessive wear. This shoot should also be provided with side boards to prevent the material spreading. The load must not be delivered on to the band over a set of supporting rollers, but at some intermediate point, and the rate of feed should be regulated. Each similar detail of design and operation to avoid wear increases the life of the bands.

The discharge from the bands may be made by means of a throw-off carriage, which, for filling bins, is often made to move automatically backwards and forwards on its track.

Band conveyors can be used for elevating, provided that the inclination is not more than 20 degs. With some materials this angle may be increased to 25 degs.

The capacity of heavy band conveyors is approximately given by the formula—

$$C = \frac{w.s.b.^2}{72,000},$$

where C is the capacity in tons per hour; *w* is the weight of the material per cubic foot; *s* is the speed of the belt in feet per minute, and *b* is the width of the belt. The capacity can be more closely estimated by reference to a scale drawing showing the character of the loading.

The power required to drive band conveyors varies enormously with the workmanship and design of the installation.

Ball bearings and other devices for reducing friction are coming into favour on account of the increased efficiency obtained. A useful estimate of the power required is given by—

$$\text{H.P.} = \frac{(W.L.e + f.w.s. + W.h)}{33,000},$$

where W is the weight of material in lbs. conveyed per minute; L is the length of the conveyor in feet, and *e* is a friction coefficient, approximately .08; *w* is the weight of the moving parts of the conveyor at the speed of the belt (the equivalent weights of the pulleys and guide rollers may be calculated); *s* is the speed of the belt in feet per minute, and *f* is a frictional coefficient, approximately .03; *h* is the height in feet through which the material is lifted, which, of course, may be negative.

Throw-off carriages absorb power in proportion to their size. A rough approximation for belts over to ins. wide is given by—

$$\text{H.P.} = \frac{b}{8} - 1.$$

Belt conveyors with fabric belts require little power, and the wear and tear is small, but they are expensive in first cost. The load cannot be withdrawn in a simple way, and the number of small bearings to be attended to and kept in repair is great.

(Concluded.)

THE OCCURRENCE OF ARSENIC IN SOILS.¹

By J. E. GREAVES, Utah Experiment Station, Logan.

Introduction.—Kunkel² showed the presence of arsenic in many rocks and waters, while Czapek³ states that traces, are nearly always present in soils. Herzfeld and Lange⁴ found arsenic in certain German raw sugars, and traced it to the lime which had been used in the manufacture of the sugar. Headden⁵ found some virgin prairie soils relatively rich in arsenic, an observation in accord with my own experience. I have found arsenic to the extent of 4 parts *per million* in virgin soil; and, as in the cases referred to by Headden, it did not result from smelter fumes or any such source, but was derived from the decay of native rocks. On the other hand, Headden found arsenic in some cultivated orchard soils to the extent of 138 parts *per million*. He claims that in many places arsenic is accumulating in sufficient quantities to become injurious to vegetation. Francois,⁶ however, considers there is little danger of the earth becoming unfit for vegetation from the proper use of insecticides. Grunner,⁷ who found arsenic to the extent of from 0.026% to 1.426% in the Reichenstein soil, is not so optimistic. It appears, however, that it is not so much the total quantity of arsenic present as the form in which the arsenic occurs, that determines toxicity. Little work has been done on this phase of the question. I have therefore determined the quantity of arsenic, both total and water-soluble, in many of the orchard soils of Western America, and it is the purpose of this paper to consider briefly a few of these results.

Experiments.—The water-soluble arsenic was determined by extracting for eight days, 500 gms. of soil with 2,000 c.c. of carbon-dioxide-free distilled water, and then using an aliquot part, while the total arsenic was determined by extracting the soil with nitric and sulphuric acids, and applying the Marsh method so modified that the iron did not interfere.⁸ The results are given in the accompanying table (1) as parts *per million* of dry soil.

TABLE I.
Data pertaining to the quantities of arsenic in soils: parts *per million*.

Total arsenic.	Water sol. arsenic.	Per cent. soluble.	Total arsenic.	Water sol. arsenic.	Per cent. soluble.	Total arsenic.	Water sol. arsenic.	Per cent. soluble.
102	0.92	0.9	36	3.48	9.67	16	0.72	4.50
79	6.20	7.85	33	5.16	15.63	15	1.74	11.60
64	4.1	6.41	32	3.92	12.25	13	0.84	6.46
63	6.88	10.92	32	1.07	3.34	12	3.85	32.08
63	1.02	1.62	24	3.56	14.83	12	0.70	5.83
62	3.38	5.45	24	1.32	6.33	11	3.40	30.91
60	1.00	1.67	20	1.08	5.04	11	1.36	12.36
55	8.87	16.13	19	6.08	30.20	10	0.88	8.80
50	4.68	5.36	19	Traces	—	9	3.13	34.78
45	4.3	9.55	18	1.36	7.56	5	3.08	61.60
45	1.8	4.00	18	0.48	2.67	5	1.08	20.80
40	5.2	13.06	17	0.36	2.12	5	1.08	21.60
39	0.68	1.74	16	2.50	15.60			

From the data in the table it may be seen that some orchard soils contain large quantities of arsenic and some carry comparatively large proportions of it in the water-soluble form; but there is no uniform relationship between

¹ *Biochemical Bulletin*, 1913, I, 519.

² Kunkel. *Zeitschr. f. physiol. Chem.*, 1905, xlv., p. 511.

³ Czapek. *Biochemie der Pflanzen*, 1905, ii., p. 862.

⁴ Herzfeld and Lange. *Chem. Abs.*, 1911, v., p. 2342.

⁵ Headden. *Proc. Col. Sci. Soc.*, 1910, ix., p. 345.

⁶ Francois. *Rev. de chim. ind.*, 1912, xxiii., p. 124.

⁷ Grunner. *Landw. Jahrb.*, 1910, xl., p. 517.

⁸ Greaves. *Jour. Amer. Chem. Soc.*, 1913, xxxv., p. 150.

the total arsenic in soils and the water-soluble arsenic. If, as is most likely the case, the injury to plants is due to the water-soluble arsenic, greater injury would result in a soil containing only 5 parts *per million* of total arsenic with 61.60% of the arsenic water-soluble, than in a soil containing 102 parts per million, in which only 0.9% of the arsenic is water-soluble. It may be seen, further, that one of the above soils, which contains 63 parts *per million* of total arsenic, has only 1.62% in soluble form, while another soil, having exactly the same amount of total arsenic, contains 10.92% in soluble form.

Arsenic in soil is not confined to the surface. One soil, obtained at a depth of 3 ft., yielded 11 parts per million of total arsenic, 30.91% of which was water-soluble.

It may be safely concluded, from the above data, that some virgin soils contain arsenic in large quantities, but that the proportion in a soil is no index of the amount which is soluble in water. The latter is probably governed by many factors, *e.g.*, kind of soil, water-soluble salts in it, and form in which the arsenic was applied to the soil.

The latter factor has been tested by applying the same quantity of different forms of arsenic to different portions of the same soil and then determining the quantity of water-soluble arsenic present in the soil. The soil used was a typical bench soil—a sandy loam—fairly high in content of calcium and iron, and supplied with an abundance of all the essential elements of plant food with the exception of nitrogen, which was low as is characteristic of the arid soil. The proportion of water-soluble salts in the soil was low. The influence of the soil on the solubility of the arsenical insecticide was determined as follows: Quantities of lead arsenate (21.96 % of arsenic), Paris green (47% of arsenic), zinc arsenite (31.25% of arsenic) and arsenic trisulphide (60% of arsenic), were added to 100-gm. portions of soil in quantities sufficient to give 112 mgms. of arsenic per 100 gms. of soil. The soil and arsenic, together with 2 gms. of dry blood, were placed in sterile tumblers, covered with Petri dishes, the water content made and kept at 18%; and then each mixture was incubated at 28° C. for three weeks. At the end of this time the soil was transferred with 1,000 c.c. of carbon-dioxide-free distilled water, to large acid bottles. The mixture was left in these bottles with occasional shaking for eight days, then filtered and the arsenic determined in an aliquot part. In another set each quantity of insecticide was mixed with a 100-gm. portion of soil and 2 gms. of dry blood, and the water-soluble arsenic determined as above, without incubation. All determinations were made in duplicate. The data are given in Table 2, as mgm. of water-soluble arsenic in 100 gms. of soil either before or after three weeks' incubation (112 mgms. of arsenic had been added to each).

TABLE 2.

Data pertaining to the water-soluble arsenic in soils mixed with arsenical insecticides.

Treatment.	Lead arsenate.	Paris green.	Zinc arsenite.	Arsenic trisulphide.
	mgm.	mgm.	mgm.	mgm.
Incubated three weeks. Water-soluble arsenic determined.	14.3	80.80	36.9	50.0
Water-soluble arsenic determined direct.	20.2	82.00	31.7	5.6
Average.	17.3	81.40	34.3	27.3

These results show that there may be a great difference in the quantity of water-soluble arsenic existing in the same soil to which various forms of arsenic have been added in equivalent quantities; and that even a soil comparatively rich in iron and calcium, to which arsenic has been added in large quantities, may have a high water-soluble content of arsenic. It is much higher when arsenic is added in the form of Paris green, than when added in the other forms mentioned. The solubility of the compounds, with the exception of arsenic trisulphide, is not greatly changed on standing in a soil containing a large quantity of decomposing organic matter.

The results also show the superiority of lead arsenate over any of the other arsenical insecticides. Any injurious effect of such compounds on plants must be proportional to the available amount of *water-soluble* arsenic, not to the *total* arsenic. In the use of an arsenical insecticide it should be the rule to select a compound which would remain insoluble for the greatest possible length of time. Lead arsenate possesses this advantage in high degree.

Summary.—Some virgin soils contain arsenic in appreciable quantities which comes from the decay of the native rocks. Many cultivated orchard soils contain it in large proportions, but there is no uniform relationship between the total quantity of arsenic in different soils and the water-soluble arsenic of these soils. A soil containing over 100 parts *per million* of total arsenic contained much less water-soluble arsenic than did a soil carrying only 5 parts *per million* of total arsenic. The solubility of the arsenic found in a soil is governed largely by the salts in the soil and the form in which the arsenic is applied. Different portions of the same soil, to which equivalent quantities of various so-called insoluble arsenical compounds had been added, showed great dissimilarities in water-soluble arsenic content. The portion to which Paris green was added contained four times as much water-soluble arsenic as did a portion of the same soil to which an equivalent quantity of lead arsenate had been applied. Arsenic trisulphide, when first applied to soil, is less soluble than lead arsenate, but as time progresses, at least in some soils, the arsenic trisulphide becomes more soluble. For this reason lead arsenate is probably safer than any of the other arsenical insecticides.

Biochemical Studies of Selenium.—V. E. Levine. Opposed to the current opinion that organic substances, generally, reduce alkali-selenite solutions, we find that reduction is not induced by alcohols, phenols, saturated and unsaturated organic acids (except formic acid, lactic acid, gallic acid), amino acids, purin bases, proteins, fats and other lipins such as lecithin and cholesterol. Acetylene, hydroxylamine and phenylhydrazine cause very strong reducing effects. Acetone and formaldehyde reduce acidified solutions of sodium selenite. Many carbohydrates reduce alkaline sodium selenite to colloidal or red amorphous selenium. Inorganic substances, *e.g.*, ferrous sulphate, stannous chloride, zinc and hydrochloric acid, sulphurous acid, arsenious acid, phosphorous acid, hydrobromic acid, hydriodic acid, also exhibit reducing power. Hydrogen peroxide, free halogens, nitric acid, potassium permanganate, and aqua regia, because of their oxidizing activity, inhibit or may entirely prevent the formation of colloidal or precipitated selenium (reduction).—*Biochemical Bulletin*, 1913, 11, 554.

ENGINEERING NOTES.

By R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

Mechanical Scrubbing for Producer Gas.

A paper, in which this matter was dealt with, was read before the American Society of Mechanical Engineers by a Mr. F. H. Smith in the early part of December of last year.

The essential part of the apparatus for performing this function described by Mr. Smith is a diaphragm of more or less compressed glass-wool between two metal screens or sieves which serve to hold the glass-wool pad together. This diaphragm is mounted transversely in the short arm of a T in the gas main, and below it is another inverted T which leads through one of its shorter arms into the continuation of the main. The action is at once apparent, and is said under suitable conditions to be very satisfactory.

The suitable conditions are (1) that the gas should be sufficiently warm to prevent a really viscous condition in the tar; (2) that the gas should not be too hot to deposit its tar; and (3) that the speed of the gas should be moderately high, say that due to a pressure of 4 or 5 lbs.

The reason and use of the two first conditions is fairly apparent; the tar must not be in a gaseous state but only in a state of minute mechanical suspension or it will pass through any screen (once warmed) with the gas; but on the other hand, if the gas is thoroughly cooled by the passage of free water through it, what tar escapes the water will be so viscous as to stick on and clog the glass-wool. The reasonable cooling of the gas is effected by something in the nature of a suitable water condenser, and under these circumstances the tar trickles down from its surface, to be drained away and collected. The third point as to speed is not so obvious; but its explanation is to be found in the breaking up and eddying of the gas stream, which allows the more tenuous portion (the genuine gas) to pass on, but prevents the tar being dragged through therewith partly by friction and partly by the fact that the fast moving gas does not go in straight lines through the diaphragm. The author of the paper suggested that the same diaphragm, if made of say steel-wool, would not be nearly so effective even if of the same consistency, and offered a theory as to electrical effect and potential difference; but this needs some definite proof, as on the face of it, it seems likely that a wire-wool and a glass-wool diaphragm might be very difficult to construct of at all the same density and frictional effect.

The apparatus has been working satisfactorily for 18 months and passing about 400 cub. ft. per hour per sq. in. on the gas of a bituminous coal containing about 30—35% of volatile matter.

If the apparatus described could be applied to all gases it would have a very large field of usefulness, for it is simple, inexpensive, easily adjusted and cleaned; but it seems that it cannot be got to work in quite so satisfactory a manner for a coal producing a heavy viscous tar at low or moderate temperatures. Were it suitable to all producer fuels it would at once remove a very large obstacle to producer-gas engines for marine propulsion, for the awkwardness and bulk of any effective scrubber at present militates almost as much as anything against this application of producer gas.

A point which should not be overlooked is that should this apparatus prove of very general utility, it would pro-

duce what to tar distillers would be a very great boon—a practically dry tar.

The Complete Gasification of Coal.

Dr. Strach, of Vienna, has for several years been making attacks on this problem, and there are now in the neighbourhood of the city mentioned several plants working on his principle and achieving results—of sorts—in this direction.

As is well known, the nearest approach to such a consummation in this country is that obtained by making watergas in a producer with the coke obtained from the ordinary gas retort. The great objection to the process in this form is its discontinuity and the loss of sensible heat in the coke dumped from the retort, which coke is at once copiously watered so that it may be handled for conveyance to the producer house, and also that it may not make the retort house itself untenable.

The disadvantage of the Strach process, is an obvious one—namely, that the gas produced is of a quality distinctly inferior to the usual product of an English gas company, the B.T.U. per cub. ft. being only about 370.

The plant is simply a coal gas-producer somewhat similar to a blast furnace in design, and the poor gas made during the blow is used to coke and gasify the coal contained in an internal retort; this coal when coked is ingeniously shot into the lower part of the producer, where it is partly converted into gas for external use and partly into poor gas, during the "blow" period before mentioned, to coke the layers above in the internal retort.

This short description of the process will at once make clear the advantages and disadvantages described above but from the gas-making point of view the retention of the sensible heat in the coke for a useful purpose in the actual process of manufacture should, if the gas can be sold on a price per thermal unit basis, prove advantageous and distinctly more profitable to the supplying concern.

It is also claimed for the process that a high yield of sulphate of ammonia and benzol is obtained, and this again is in its favour.

Systems on lines somewhat analogous to the above are at present being tried and it is believed with success at Birmingham, Hull, Leeds, and Sunderland.

Marine Propulsion by Other than Coal to Steam Methods.

Many writers or speakers of authority—to mention only a few, Messrs. Redwood, Tookey, and Gander—have held forth in print or speech very recently on the above and kindred points. Briefly summarised, the methods of applying gas or oil fuel to the propulsion of the Royal or Mercantile Marine are as follows:—

- (1) Burning oil as a fuel, instead of coal, by means of special nozzles in the fire-box.
- (2) Burning oil directly in the Diesel or similar engine cylinder.
- (3) Burning producer gas in a gas engine.
- (4) Burning producer gas or oil in an internal-combustion turbine.

The last mentioned is at present also the least, as no really practicable form of this kind of heat engine has yet made its appearance—and at the moment its successful advent seems about as far off as ever.

Omitting it (the internal-combustion turbine) from our immediate consideration, the points in favour of the above methods are in the case of

(1) The need of a somewhat smaller storage capacity and a greater flexibility in the control of combustion. These two points make this method particularly suited to the Royal Navy, and in that service they find at present their chief application.

(2) The same applies but with great reservations, owing to mechanical and thermal difficulties at the engine itself. This method and No. 3 have a great theoretical thermal advantage.

(3) The same applies but with reservations as to scrubbing and other difficulties, together with similar cylinder troubles.

The disadvantages are, in

(1) That, thermodynamically, this is the least efficient way of converting the internal energy of the fuel into work.

(2) The great heat of compression and explosion render efficient cylinder cooling a *sine qua non*, and with cylinder volumes suited to the horse-powers required in the larger type of ship efficient cooling becomes almost impossible. This defect is undoubtedly the chief stumbling-block in the progress and adoption of this type of engine for all but moderate powers.

(3) The disadvantages in (2) apply in a somewhat lesser degree to (3), but here the difficulty of satisfactory scrubbing is added, and this difficulty is a very serious one.

It therefore appears that the only method at present available and suitable for large powers is No. 1, and this, alas for novelty, scarcely differs in principle or efficiency from burning coal.

PERSONAL AND OTHER NOTES.

THE Educational Committee of the London County Council recommend maintenance grants towards the London University amounting to £74,700, the payment extending over the years 1914—1918. The question of a grant of £30,000 towards the building of the new chemistry laboratories at University College is being considered. A. H. Cooke and H. H. Thomas have been approved for the degree of Doctor of Science by the Cambridge University General Board of Studies.

The Iron and Steel Institute holds its annual meeting on May 7th and 8th at the Institution of Civil Engineers, when the Bessemer Gold Medal will be awarded to Mr. Edward Riley.

Professor E. Heyn of Berlin will deliver the Forthor May lecture before the Institute of Metals on "Internal Strains in Cold Wrought Metals and some Troubles caused thereby."

The president elect of the Iron and Steel Institute is Dr. Adolphe Greiner.

Among the list of officers elected to the Physical Society for the ensuing year are the following:—*President*: Sir J. J. Thomson, O.M.; *Vice-Presidents*: Messrs. T. Mather, A. Russell, F. E. Smith, R. S. Whipple; *Other Members of Council*: W. H. Eccles, D.Sc., Sir R. A. Hadfield, F.R.S., Professor G. W. O. Howe, M.Sc., Professor J. W. Nicholson, M.A., D.Sc., Major W. A. J. O'Meara, C.M.G., C. C. Paterson, Professor O. W. Richardson, M.A., D.Sc., F.R.S., Professor the Hon. R. J. Strutt, F.R.S., W. E. Sumpner, D.Sc., R. S. Willows, M.A., D.Sc.; *Assistant Secretary and Reporter*: J. Guild, A.R.C.S., D.I.C.

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, *Chartered Patent Agent,*
Queen Anne's Chambers, Westminster, S.W.

20758/12. W. A. HALL. **Sulphur.**

In the production of sulphur from pyrites, the pyrites are subjected to the action of a reducing flame and of a limited amount of steam which is in itself insufficient to decompose the pyrites to any substantial extent, but is sufficient to prevent substantial loss due to formation of SO₂ and COS.

21826/12. W. A. HALL. **Decomposition of Complex Ores.**

A process for the decomposition of complex ores or concentrates, such as those of zinc, lead and iron in the form of sulphides, consists in subjecting the ore or concentrates to the action of a reducing flame and of a limited amount of steam, which is in itself insufficient to decompose the ore or concentrate, for the removal of some sulphur in elemental condition and of the volatile metallic sulphides.

24692/13. FARBENFABRIKEN, VORMALS FRIEDRICH BAYER & Co. **Pipithazoic Acid.**

The improvements in the extraction of pipithazoic acid consist in extracting the radix pipitzahuac with organic solvents at ordinary temperatures.

1616/13. F. C. W. TIMM. **Process and Apparatus for the Condensation of Vapours of Volatile Metals, especially of Zinc Vapour.**

1924/13. G. J. LEMMENS. **Cooling Molten Fats.**

The method of cooling molten fats consists in exposing a stream thereof to the action of a blast of compressed cold air, the treatment and final degree of compression of which is such that the subsequent expansion of such air when in contact with the fat produces a rapid abstraction of heat from the fat and causes it to be solidified in desired crystalline form.

2484/13. SOCIETA ANONIMA ITALIANA GIO. ANSALDO & Co. **Steel Treatment.**

In the process of treating steel ingots or castings wherein the ingot or casting for the purpose of preventing piping is gradually cooled from the bottom upwards, the metal in the upper portion being retained in the liquid condition during the cooling of the portion below, the ingot or casting is, according to this invention, heated by electric currents induced in the metal by means of an alternating current in a coil surrounding the metal to be treated.

3660/13. ACTIEN-GESELLSCHAFT FÜR ANILIN-FABRIKATION. **New Sulphurised Dyestuffs.**

New sulphurised dyestuffs are manufactured by acting with a sulphurising agent, such as, for example, sulphur or polysulphide, upon a mixture of an alkyl derivative of para-oxydiphenylamine with an aromatic amine.

26595/12. W. A. HALL. **Sulphur.**

In the production of sulphur from sulphides of zinc, copper and lead, the sulphide is subjected to the action of a reducing flame and of a limited amount of steam which is in itself insufficient to decompose the sulphide to any

substantial extent, but is sufficient to prevent substantial loss due to formation of SO₂ and COS.

27147/12. G. TISCHENKO and H. PLAUSON. **Steel or Iron.**

In the process for manufacturing steel or iron in accordance with this invention, electrolytically refined iron is melted and pure hydrocarbons in the form of gas or vapour are thereupon sucked or forced through the molten mass.

27323/12. MINERALS SEPARATION, LIMITED, and A. H. HIGGINS. **Ore Treatment.**

In the process, according to this invention, for the treatment of ores, the recovery of the metalliferous matter is effected partly by a flotation process and partly by a lixiviation process.

24692/13. FARBENFABRIKEN, VORMALS FRIEDRICH BAYER & Co. **Sulphur and Sulphates.**

The process for the production of sulphur and sulphates, with the exception of ammonium sulphate, from sulphites consists in heating solutions of mixtures of acid and neutral sulphites, with the exception of a mixture of acid and neutral ammonium sulphite.

28943/12. SIEMENS and HALSKE AKTIENGESELLSCHAFT. **Quantitative Analysis of Gaseous Mixtures.**

In means for indicating the relative proportions of the gases present in a gaseous mixture of known constituents by the pressure differences required to produce a certain acceleration in the gaseous mixture and in a gas of known composition, the pressure differences are caused to act on a single reading instrument.

4842/13. A. HAMBLOCH and S. GELLER. **Improvements in Treating Silicate Rocks and Recovery of Alkalies therefrom.**

5248/13. BADISCHE ANILIN UND SODA FABRIK. **Improvements in the Manufacture and Production of Colouring Matters of the Benzanthrone Series and in Dyeing and Printing therewith.**

5553/13. VEREINIGTE KUNSTSEIDEFABRIKEN A.G. **Nitro-cellulose.**

Nitrocellulose is prepared by nitrating cellulose, and as soon as nitration has been effected and centrifuging, washing the nitrated material with acid which exerts no further nitrating action on the material and is cooler than the material in order to prevent spontaneous decomposition.

11104/13. F. STEIMMIG. **Viscose.**

This process for the manufacture of filaments and films from viscose consists in squirting the viscose into a settling bath composed of a concentrated solution of a neutral salt and a small percentage of an ammonium salt, such as ammonium sulphate.

12784/13. L. F. BULLÔT. **Preservation of Alimentary Substances.**

In the improved dry process for the preservation of alimentary substances, such as meat, poultry, game and the like, the substances, after exposure to the action of a fumigating mixture consisting of vegetable charcoal, golden wattle bark, sulphur, saltpetre, extract of eucalyptus and oil of cinnamon, are subjected to treatment by chlorine gas.

13826/13. C. K. F. L. GROSS. **Synthetic Caoutchouc.**

Caoutchouc is manufactured from isoprene by treating the isoprene in a closed chamber with trioxymethylene and heat.

17857/13. A. S. RAMAGE. **White Lead Manufacture.**

The method of preparing basic carbonate of lead from lead sulphate consists in acting upon lead sulphate with an alkali carbonate in less proportion than is required for the conversion of all of the sulphate into carbonate, and treating the resulting product with an alkali hydroxide.

19463/13. CONSORTIUM FÜR ELEKTROCHEMISCHE INDUSTRIE G.m.b.H. **Improvements in and relating to the Manufacture of Aldol and Crotonic Aldehyde.**

22836/13. BADISCHE ANILIN UND SODA FABRIK. **Colouring Matters.**

Compounds and colouring matters of the anthracene series are manufactured and produced by treating carbazole or halogen derivatives thereof or their homologues with phthalic anhydride or a halogen derivative thereof in the presence of sulphuric acid.

25830/13. F. POLLAK. **Formaldehyde.**

A process for the production of, crystallised para-formaldehyde is characterised by the fact that amorphous para-formaldehyde is dissolved in solutions of acids or of salts exerting an acid action, or it is treated with such solutions below the solution temperature, and then allowed to cool, preferably slowly.

26061/13. GESELLSCHAFT FÜR ELEKTRO-OSMOSE, m.b.H. **Electro-Osmotic Processes.**

A method of conducting electro-osmotic processes in which a strong fractionation of the suspension is achieved by causing the latter in its passage to the anode to wash against a cathode surface as large as possible.

29833/12. V. BEER. **Refining Petrol or Benzine.**

A continuous process for refining benzine or petrol consists in forcing the benzine or petrol under an adjustable pressure through closed vessels connected in series and charged with acid or lye at rest.

974/13. BADISCHE ANILIN UND SODA FABRIK. **Improvements in and relating to Chemical Reactions in Gases by means of Electric Arcs.**

17330/13. C. HERENDEEN. **Improvements in and relating to Processes and Machines for Treating Flour.**

18827/13. SIEMENS and HALSKE AKTIENGESELLSCHAFT. **Improvements in Apparatus for Measuring Ionisation of Gases.**

18818/13. SOCIÉTÉ ANONYME L'OXHYDRIQUE FRANCAISE. **Electrolysis.**

An electrolyser element for electrolysing water is characterised by a diaphragm made of asbestos fabric without hemmed or the like edges and rigidly maintained on two wooden frames connected together by means of plugs, said frames being provided with grooves for the outlet of the gases and of the electrolytic liquid, and by a light iron sheet or plate, undulated, embossed, or the like, in order to have an active surface as large as possible, said iron sheet forming an electrode in which are provided holes corresponding to those of the diaphragm frames and being at will nickel plated at the anode side, and provided with bent edges in which fit the wooden frames supporting the diaphragm.

19420/13. E. W. KUHN. **A New Process for the Condensation or Concentration of Milk and other Liquids by Filtration.**

REVIEWS OF BOOKS.

“THE SUGARS AND THEIR SIMPLE DERIVATIVES.”

By **John E. Mackenzie**. GURNEY & JACKSON, London, 1913. Pages 242 + xiii, including Index. Chapters XX., with 17 Illustrations. Price 7/6 net.

THIS text-book exhibits many signs of the care taken by the author in its preparation. It contains just the right kind of information for the student.

The chapter on Configuration will probably be regarded as an “eye-opener” by those who have not followed recent developments in this direction. This work claims the serious attention of those specially interested in this subject. It also forms a satisfactory reference book to a subject which is of growing importance to the general chemist, who will find in its pages a satisfactory and reliable account of past work and many indications of the direction future investigation may be expected to take. Chapters deal with the manufacture of cane and beet sugar, sucrose, maltose, lactose, glucose, the di-, tri-, and tetr-saccharides, glucosides, etc.

“ALLEN'S COMMERCIAL ORGANIC ANALYSIS.”

Vol. VIII. Enzymes, Proteins, Albuminoid Substances, Milk and Milk Products, Hæmoglobin and Blood, Proteoids, Fibroids. Edited by **W. A. Davis** and **S. S. Sadtler**. Contributors: **E. F. Armstrong, S. B. Schryver, L. L. van Slyke, H. Leffmann, C. Revis, W. D. Richardson, J. A. Gardner, E. R. Bolton, G. A. Buckmaster, W. P. Dreaper, and J. Alexander**. Fourth Edition. J. & A. CHURCHILL, London, 1914. Pages 687 + x, with Appendix and Index. Price 21/- net.

The last edition of this volume was issued fifteen years ago, and it is therefore natural that it has been entirely revised. It is the last volume to be issued; except that a supplementary one will be issued at some subsequent date, containing a complete reference volume index of the whole work, and an account of those analytical processes which have appeared in the meantime.

The short introductory chapter on enzymes will be welcomed as coming from an investigator of experience in this direction, who is also responsible for the section dealing with proteins of plants. The sections dealing with proteins of milk, and milk products, and meat and meat products contain a great deal of useful information; and the same remarks may be made about those dealing with digestion products of the proteins, hæmoglobin and its derivatives, the albuminoids, and the fibroids, which latter deals with silk and artificial silk, wool, hair, etc.

The natural development in organic analysis during the last decade having rendered it necessary to recast the whole subject, it has been no longer possible for any one analyst to deal with it, and with this concluding volume it may, perhaps, be oppor-

tune to offer a word of praise to the editors of this new edition on the way they have carried out their arduous task of selection and supervision.

“A NEW ERA IN CHEMISTRY.” By **Harry C. Jones**.

CONSTABLE & Co., LTD., London, 1913. Pages 326 + xiii, with Appendix and Index. Chapters XII. Price 8/6 net.

The author of this work is known as one of the leading investigators in America in connection with physical chemistry, and therefore this general *résumé* of the development in this direction during the last twenty-five years serves a useful purpose.

Opening with a description of the state of chemistry in 1887, the development of the law of mass action is dealt with, as well as the energy changes that take place in chemical reactions. This is followed by descriptions of the work of van't Hoff, Le Bel and Guye, and the origin of stereochemistry. Other sections deal with chemical dynamics and equilibrium, osmotic pressure, electrolytic dissociation, the solvate theory of solution.

The last part of this volume is taken up with a description of the work of W. Ostwald and his students and co-workers, and here one gains an insight into the extreme value of a “school” and the influence of its master on the work of others. The final chapter deals with the electron and radiochemistry.

The somewhat free style adopted in this work allows the student to realise the development which has taken place in chemistry during the period covered, and this book will be read with interest by all those who have the desire to obtain a general insight into this matter. For this reason it can be recommended to the general chemist, or to those who have specialised, with every confidence.

“RAYS OF POSITIVE ELECTRICITY AND THEIR APPLICATION TO CHEMICAL ANALYSES.” By

Sir J. J. Thomson. LONGMANS, GREEN & Co., London, 1913. Pages 132 + vi, with Index and 50 Illustrations. Price 5/- net.

The work of this investigator has always an interest to the chemist on account of its daring, and the extreme importance of the results obtained. It may be that the chemist would like to place a different interpretation on some of the results obtained by this investigator in order that they might more closely agree with his own ideas concerning the structure of the molecule or atom, but this is only a matter of detail, which will settle itself as time goes on and further experimental evidence is brought to bear on the subject from both sides.

The author claims that the positive ray method of analysis is of special interest to chemists, and that he is certain that many of the problems in chemistry could be solved with far greater ease

by this than by any other known method. This suggestion is a reasonable one, and it is probably only on account of the many new conditions involved in the acceptance of this view that the chemist has not yet taken a part in these investigations which are fraught with such importance. It will be remembered, for instance, that these experiments indicate the presence of an element with an atomic weight of three. The chemist is as much concerned as anyone to know what this body really is: whether it is H_3 or a new element, or whether this body only exists under the conditions of the experiment which discloses its presence.

One of these days a series of experiments of this, or a similar nature will break down the artificial division which exists between the work of the chemist and the physicist; for this is chiefly based on temperament which will be discounted in the long run by the obvious value of experimental data.

This book should be read by every chemist, for it is impossible to think that some new thought or method of attack will not be the outcome of its perusal. To the chemist it is physics at its best.

"OUTLINES OF THEORETICAL CHEMISTRY." By **Frederick H. Getman.** CHAPMAN & HALL, LTD., London, 1913. Pages 467 + ix, with Index. Chapters XIX., with 194 Illustrations. Price 15/- net.

The author of this book, who hails from America, opens his preface with a quotation from Pascal to the effect "that the last thing that we find in making a book is to know what we must put first."

Frankly the author has performed his task in a very satisfactory manner, and it is evident from a first glance at this book that it presents its subject in an exceptionally lucid manner. It is essentially a type of the modern text-book which is unhampered by past tradition, and although the price of issue seems to be a high one, yet the distinctive features of this work will find it many friends and readers in this country.

The usual subjects are dealt with, and it is hardly necessary to draw special attention to any section of the book. It is more in the general method or treatment adopted that this work will at once draw the student's attention. The illustrations are not many in number, but those included are particularly clear and satisfactory.

"A TREATISE ON CHEMISTRY." By **H. E. Roscoe and C. Schorlemmer.** Vol. II.—The Metals. Fifth Edition. MACMILLAN & CO., LTD., London, 1913. Pages 1470 + xvi, with Index. Divided into VIII. Sections with 211 Illustrations. Price 30/- net.

The present edition of this well-known work, which played so conspicuous a part under the old Science and Art Department *régime*, may still in its modern form, be regarded as a leading text-book for the use of students who are preparing for examinations. This volume opens with an account of the determination of atomic weights of the metals and the valency of the elements and their classification. It is a sign of the times that a section

is devoted to the crystalline forms of the metals and their colloidal solutions, and also that alloys and amalgams are treated at some length. Spectrum analysis and crystallography are also dealt with in a general way.

The metals are divided into, and treated under, seven groups, and in some cases the actual manufacture is illustrated by diagrams of the plant utilised.

In the present edition the author has been aided by such authorities as Mr. T. V. Barker who has rewritten the chapter on crystallography, by Dr. Makower who has dealt with the subject of radio-activity, and Dr. Spencer and Messrs. Keane and Mollwo Perkins have dealt with the metallic compounds. In this way the present volume presents satisfactory features which will recommend it to the many readers who will undoubtedly consult its pages.

"INTRODUCTION TO MODERN INORGANIC CHEMISTRY." By **J. W. Mellor.** LONGMANS GREEN & CO., London, 1914. Pages 682 + viii, with Index. Chapters XXXVII., including Appendix and 232 Illustrations. Price 4/6.

This work will be welcomed as a satisfactory addition to the already large number of others which deal with inorganic chemistry at its introductory stages. It is impossible within the space available to indicate the wide nature of the ground covered, but this work can be thoroughly recommended to those desiring an elementary text-book which includes an account of more recent progress. It is efficiently illustrated, and contains an interesting introduction.

BOOKS, ETC., RECEIVED.

"Lectures on the Research Chemist in the Works, with Special Reference to the Textile Industry," by W. P. Dreaper. Published by The Institute of Chemistry, 1914. Pages 70, with 28 Illustrations. Price 2s. for non-members.

"Quantitative Analysis," by Edward G. Mahin. The Hill Publishing Co., Ltd., London, 1914. Pages 511 + ix, with Tables and Index. Chapters XI., with 119 Illustrations. Price 12s. 6d. net.

"Photo-Chemistry," by S. E. Sheppard. Longmans, Green & Co., London, 1914. Pages 461 + ix, with Index. Chapters XI., with Illustrations and Figures. Price 12/6.

"A Text-book of Organic Chemistry," by A. F. Holleman. Edited by A. Jamieson Walker and Owen E. Mott. Fourth Edition. Chapman & Hall, Ltd., London, 1914. Pages 621 + xvi, with Index. Divided into 2 Parts with 82 Illustrations. Price 10/6 net.

"A Laboratory Manual of Organic Chemistry for Beginners," by A. F. Holleman. Edited by A. Jamieson Walker. Second Edition. Chapman & Hall, Ltd., London, 1913. Pages 83 + viii, with Index. Sections XXXIX. Price 4/6 net.

"Chemistry and Its Borderland," by Alfred W. Stewart. Longmans, Green & Co., London, 1914. Pages 314 + ix, including Appendices and Index. Chapters XV., with 11 Illustrations and 2 Plates. Price 5/- net.

"The Nature of Enzyme Action," by W. M. Bayliss. Third Edition, Revised and Enlarged. Longmans, Green & Co., London, 1914. Pages 180 + viii, including Index. Chapters X., with 7 Illustrations. Price 5/- net.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

The Work of the Division of Chemistry of the Canadian Board of Agriculture.

The report of the Minister of Agriculture for the Dominion of Canada for the year ended March 31st, 1913, contains an interesting reference to the work of the Division of Chemistry, which has considerably increased. It appears that the Canadian farmers are greatly appreciating the benefits derived from the information which the Division is able to impart on subjects, such as the composition and properties of soils, manures, fertilisers, spraying materials, etc. The samples received for examination during the year numbered 2,821, and comprised soils, feeding-stuffs, naturally occurring fertilisers, insecticides, and other matters of an agricultural nature.

The investigatory work has covered a wide field and the results therefrom have thrown light on many problems. The conclusions drawn from the study of soils in the field and in the laboratory of the Division have given a special impetus in the carrying on of investigations towards the maintenance and increase of the nitrogen content of soils. In connection with the experiments with naturally occurring fertilisers attention has been particularly directed towards the use of ground limestone as an amendment. There seems little doubt but that this material will be found of value for sour soils and those deficient in lime, both clay and sands. A number of investigations, more or less closely related to agricultural economy, have been carried out by the Division of Chemistry, and in this way valuable assistance has been given towards the solution of several problems of wide importance.

Oil-Hardening Plant in Norway.

During the past five years great progress has been made in the hydrogenation of liquid oils, by which process these oils are chemically transferred from the "unsaturated" or liquid series to the "saturated" or concrete series. Theoretically the process is simple, consisting merely in adding two atoms of hydrogen to the oil molecule; but the means for accomplishing the above result have been complicated and expensive, though now growing more simple. An interesting plant for treating oil according to a new hardening process was opened last summer at Fredrikstad by the Nordiske Fabriker with head offices at Christiania. The original object was to harden whale oil for the soap industry, but as the result of experiments with edible oils the plant is being enlarged to a capacity of 1,000 barrels a day with the expectation of hardening cottonseed and peanut oils for the margarine makers. If this plan is successful it may double the consumption of cottonseed oil in the margarine industry.

Some criticism has been directed at the use of hardened oils for edible purposes on the ground that nickel is employed in the process, but the manufacturers say that although nickel is generally used none of it is left in the oil, and that even if it were it is harmless, as shown by many tests with animals and with human "poison squads."

The Struggle in the German Sulphate of Ammonia Industry.

The German sulphate of ammonia industry is the scene of a fierce competitive fight between two groups of manufacturers of the article in question. On one side we have the German ammonia combination of Bochum, and on the other side the well-known chemical concern at Ludwigshafen, the Badische Anilin-und Sodafabrik. The latter is a great producer of sulphate of ammonia according to chemical methods, while the Bochum manufacturers work in the usual manner. The Ludwigshafen concern is endeavouring to obtain a firm footing in the market by selling cheaper than the other makers.

In order to prevent the Badische Anilin-und Sodafabrik from acquiring the consumers of ammonia who are, at present, dealing with the Bochum manufacturers, the latter are now trying to pledge their buyers by an agreement not to deal with middlemen, in return for which they receive a discount of 10% on running contracts at the end of the season.

The importance of the combination of Bochum makers may be judged from the fact that their sales amounted to some 300,000 tons in 1912, representing nearly three-fifths of the whole output in Germany during that year. The producers in other parts of the Fatherland, *e.g.*, those in Upper Silesia, Rhineland, and Westphalia, are said to be quite willing to enter into a competitive struggle with the Ludwigshafen concern, asserting that the cost of producing artificial ammonia is more than the cost of producing the fertiliser in the coke and gas works.

According to a late report the competition among producers of ammonia has been settled and prices will no longer be subjected to cutting in order to obtain orders. The Bochum interests have given notice that they do not propose to make any further reduction for the spring season. The production of synthetic sulphate will not be considerable for many months to come, but the factory is said to be constructed for 30,000 tons per annum, and later on the production is likely to be 100,000 tons. The producers have acquired interests in German fertiliser concerns, so as to place the security of sale in Germany beyond the limits of interference.

The struggle is watched with keen interest by consuming interests, as a reduction of prices seems inevitable.

Surgical Bandages of Cellulose.

Aviators are well acquainted with the process by which a French inventor succeeded in obtaining an even tension in the wings of aeroplanes by means of saturating the fabric with a solution of cellulose. The process has now been adapted by a surgeon of Tours, Dr. Guillaume Louis, to the preparation of fabrics for the construction of surgical apparatus. After studying the results obtained by various solvents of cellulose, Dr. Guillaume Louis finally adopted acetone, with which he obtained a white liquid of opaline lustre, called by him "pelliculine," a term the English equivalent of which would be "filmine." "*Le Correspondant*" gives an abstract of the report on his experiments recently furnished by him to the "*Province Médicale*":—

"Pelliculine, which looks like collodion, leaves, on drying, a film which is both incombustible and resistant, and which imparts to strips of cloth impregnated with it sufficient stiffness to permit of their being used to construct light apparatus for holding injured limbs in position. The fabric is more supple and more resistant than potassium silicate, and dries more quickly. It is much superior to celluloid, since it is incombustible and more easily manipulated, besides being cheaper. It can be used to varnish dry plasters, making them impermeable and pliable. Celluloid becomes incombustible when varnished with it, and, finally, it furnishes, either pure or with the addition of iodine, a valuable substitute for collodion.

An Association of German Potash Producers.

As a protest against the legal restrictions imposed upon the potash syndicate by the German Reichstag, steps have been taken by the concerns affected for the formation of an association for mutual assistance and co-operation. The practical work to be accomplished by the association mainly consists of an agreement binding the producers, within and outside of the syndicate, not to build new plants for a period of six years.

A Projected Dairy Institute in Germany.

The formation of a central dairy institute in Germany which has been aimed at by interested parties for many years, is confronted by many difficulties, according to a recent statement by the Minister of Agriculture, Freiherr von Schorlemer. There are about ten institutions in existence for the study and research in dairy science, most of which are connected with chambers of agriculture. They are subsidised by the Government to the extent of 190,000 marks per annum. It would, therefore, be scarcely easy to form another great central institution without impairing the grants to the chambers of agriculture. At the same time, the German Government is most anxious to bring about a centralisation of dairy research, either by forming a great new institution or by enlarging one of the existing ones in order to create a centre.

Milk from Soya Beans in Germany.

The continental press recently circulated an interesting report on some experiments in producing artificial milk from soya beans and similar vegetables. At the recent meeting of the Associated Farmers (Vereinigte Landwirte) at Frankfurt on the Main, it was stated that it is proposed to produce some 50,000 litres of soya bean milk per diem, as soon as the experimental stage is passed. The concern carrying on the experiments under the style of "Soyama Works," has an enormous working capital and the management comprises some well-known financiers and agriculturists. When the works are fully established it is proposed to produce not only milk but also butter, cream and cheese. The dairy farmers of Central Germany are watching the development of this wealthy competitor with considerable anxiety.

A Technical Department for German East Africa.

With the object of aiding the development of the German colonies in East Africa, the Colonial Committee have decided to organise a technical department with headquarters at Dar-es-Salam. Two branch establishments are to be erected at Tanga and Lindi, both of which places are important centres of agriculture in the German colony.

The technical department will be under the management of thoroughly efficient men with academic training and considerable practical experience, who are to keep themselves in readiness to render practical aid or act as advisers on all matters connected with the planting industry or other subjects falling within the scope of a technical advisory department. One of the tasks of the assistants will be to travel from farm to farm studying the machines and apparatus in use with the object of introducing improved methods or make suggestions for reducing hand-labour. The planters are at liberty to make use of the services of the department at a nominal fee, and it is hoped that this step will greatly benefit the colony.

Search for New Oils.

The high prices ruling in recent years for most of the fixed oils and fats of commerce has stimulated inquiries into the utilisation of some new or little-known oil seeds and oils, together with their by-products, in order to supplement the supply of standard commodities. In British tropical dependencies exploitation on a commercial scale of various kinds of oil seeds is receiving special attention at the present time; and it is therefore interesting to note the results of examination in the laboratories of the Imperial Institute of some of the more promising products.

The well-known safflower (*Carthamus tinctorius L.*) of the Middle East, the flowers of which yield a rose-coloured dye, is now grown in parts of India for the seeds alone, the better quality of the oil expressed being used for culinary purposes. Penang kernels from Bengal, yielding a large percentage of oil, were valued at £16 per ton in the United Kingdom (April, 1913) for soap making, but the high acid value of the oil would render it unsuitable for edible purposes. Illipe oil from Mauritius (derived from the kernels of *Bassia latifolia*), made into a homogeneous pasty yellow fat yielded a hard yellow soap equal to the product of good palm oil, but could not be used as a substitute for high-grade tallow or as an edible fat.

United States Tariff on Chemicals.

With regard to chemicals, medicinal compounds, etc., put up in individual packages of 2½ lbs., or less, gross weight, paragraph 17 of the new tariff provides that: "Chemical and medicinal compounds, combinations, and all similar articles dutiable under this section, except soap, whether specially provided for or not, put up in individual packages of 2½ lbs., or less, gross weight . . . shall be dutiable at a rate not less than 20% *ad valorem*." It is held that all the articles provided for in Schedule A of the tariff (chemicals, oils and paints), whether *eo nomine* or not, except soap and sponges, and also all articles provided for in the dutiable schedules of the tariff elsewhere than in Schedule A, which, in fact, consist of chemical or medicinal compounds or combinations, or articles similar thereto, are subject to the minimum rate of duty when put up in such packages.

Japanese Iodine.

According to a report from Yokohama the manufacture of iodine is carried on in a small way in different parts of the country, the chief factory being at Hyama, about 20 miles from Yokohama. While no statistics of production are obtainable, it appears from the customs returns of Japan that nearly 23,000 pounds of iodine were exported during last year, principally to the United Kingdom and Germany.

CONSULAR REPORTS.

Borax and Salt in Argentina.

According to a British consular report the national territory of the Andes, a barren country with hardly any population, is reputed to contain rich deposits of borax. The mines could not withstand the competition of the Chilian and Peruvian deposits. The concessions granted are in the hands of the *Compagnie Internationale des Borax*, which practically controls the world's supply. The deposits are believed to be rich enough to affect the market considerably if they were to fall into other hands than those of the trust. Private borax prospecting is no longer allowed in the district, and nearly all the companies which have tried to work the deposits have come to grief.

Salt is to be found in many districts, but in most cases the deposits are too far removed from the railways. The most valuable, if not the most extensive, salt industry is near Bahia Blanca, about eight miles from the Great Southern Railway. The output now amounts to 30,000 tons. Labour-saving machinery is needed.

Chemicals in Italy.

The importation of benzine in Italy in 1912 shows an increase of 25%. This is attributed to the increasing number of motor cars and vans in use in Italy. The imports which contributed to the increase in chemical products were caustic soda (France, the United Kingdom and Germany), carbonate of soda (the United Kingdom, France and Germany), sulphate of potash (Germany), glycerine (France and Germany), quinine salt (Germany and Dutch India), and chemical products not specified (Germany, France and the United Kingdom).

The increase of exports was due chiefly to the larger exportation of oxide of iron and oxide of zinc to the United Kingdom, and of carbonide of calcium to the United Kingdom and Portugal. The exportation of tartar and chemical products has also increased. Matches used to be exported in large quantities to Australia, but in 1912 there was a fall of about 50% in the demand from the Commonwealth.

Rape-seed Oil Production near Shanghai.

Rape-seed is termed by the Chinese trade "cabbage seed," while Chinese farmers style it "cabbage-oil seed." As grown in the Loongwah district, near Shanghai, one mow yields 200 catties (equal to 1,600 lbs. per acre), provided the soil is favourable. Soochow and Hangchow are the principal growing centres in these regions. The oil is extracted by circulating grinding stones, one imposed above the other. These mills are operated by hand, the larger ones with the aid of water buffalo. In Shanghai there is a power oil mill under British management. Another foreign mill closed down a year ago in financial difficulties. The merchants who export this commodity as seed clean it with machines before shipment. The exports of rape-seed oil are considerably more important than those of rape-seed.

Production of Nitrate of Soda in Chile.

A report on the production of nitrate in Chile has been received at the Commerce Department at Washington from Valparaiso. It appears that during the first ten months of 1913 the production of nitrate in Chile aggregated 51,034,887 cwt., with the prevailing price of \$1.85 per cwt. The figures are quoted in comparison with the production of 46,548,559

cwt. in the corresponding months of the previous year, with prices ranging at about \$2.32 per cwt. Commenting upon the situation generally, the report says: "The outlook is not very promising, but a fair profit can be made by most of the producers at the present price."

Japanese Matches in India.

The French Consul at Kobé reports a rumour current in Japan to the effect that a company with a capital of £30,000 has been formed in London for erecting a large match factory in India with a view to cutting out the Japanese match trade with that country. At present India imports Japanese matches to the value of 1.77 million yen per annum, of which 1.60 millions are paid for safety matches. The Japanese export houses and their agents, the Bantos, exercise considerable pressure on makers to supply them at very low prices, without troubling about the quality of the goods, and in consequence Japanese matches are getting out of favour in India. In the large cities European matches are already being preferred to those of Japanese make, and the manufacturers are finding their market restricted to the smaller centres and the plains country. The Japanese manufacturers are credited with the intention of instituting a system of supervision of exported matches, so as to see that the quality is maintained, but there seems little prospect of their being able to resist the pressure of the exporters for cheapness at the expense of quality.

MARKET REPORTS.

LONDON.—Considering the fact that January and the early part of February is usually a very dull and uneventful time of the year, the business in chemicals during the period under review has been quite up to the average. The general situation in the home section has not altered very much, and leaves a great deal to be desired, which may be partly accounted for by the diminished activity in the English textile and metal industries.

Some departments of the export trade have presented quite a lively appearance during the last few weeks, though the total exports of chemicals showed a decrease in value compared with those of January, 1913. Quite a revival took place in the bleaching powder business with the United States, the exports to this market increasing by about 10,000 cwts. The soda compounds group advanced by 115,118 cwts., of which soda ash and caustic soda displayed the greatest elasticity. Putting aside coal-products, not dyes, which were £28,284 less, the whole chemical group showed a fairly well-maintained activity.

The fertiliser section is beginning to feel the beneficial influence of the advancing season and the open weather. The home buyers show visibly increased interest in sulphate of ammonia, and the export inquiry, though by no means very active, is improving week by week. The takings of American importers amounted to 7,900 tons against 4,200 tons in January, 1913, and the exports to Japan totalled 12,800 tons against 7,500 tons. This increase is quite satisfactory by itself, though hardly large enough if compared with the growth in production. The quotation for gray, 25% quality, prompt delivery, is now £11 15s. to £12 per ton. The prices of nitrate of soda are steadily maintained, although the weak tendency of freights from Chile and the unfavourable statistical position of the article on the Continent have a very depressing influence on the

market. On the other hand, however, may be mentioned that the time for consumption is very near. Much seems to depend upon the course of the market for other fertilisers. The present quotation for nitrate is 10s. 6d.—10s. 9d. for ordinary quality. The business in pitch is still impeded by the inability of sellers and buyers to come to terms. Although there are quite a number of promising inquiries in the market, the actual business does not come up to the expectations of the producers who hold out for 40s. 6d.—41s., while buyers refuse to pay more than 39s. 6d. Benzole remained rather quiet lately, though the shipments against old contracts have remained large, amounting to about 600,000 galls. during January. The French demand, formerly of great importance, has been very disappointing for some time, and it is thought that France has gone to Germany for her supply; 50% quality, prompt, is quoted at 11½d.—1s., and 90% at 1s. 1d.—1s. 1½d. per gall. Creosote benefits by a continued large demand which helps to maintain the price at about 3½d. Carboic acid is lacking, both in strength and activity, the business being quite unimportant. The price for East Coast and West Coast prompt is 1s. 0½d. to 1s. 1d. per gall. Solvent naphtha is quiet and depressed owing, it is said, to the slackness in the rubber garment trade. The nominal quotation is 9½d.—10d. per gall. Supplies of citric acid on the spot are extremely small, but only a few inquiries are in the market. English citric acid is quoted at 1s. 11d.—1s. 11½d., and foreign acid at 1s. 11¼d. Arsenic is very firm with moderate offerings and active demand. Best white Cornish powder is not obtainable under 13s. 3d. per cwt., while some sellers ask 3d. more.

MANCHESTER.—Though not very active the business in heavy chemicals remain quite fair, and most prices are well maintained. Powdered arsenic is quiet at £14, a comparatively low quotation which is not likely to be further reduced. Caustic soda is held at £8 10s.—£10 5s., according to strength. The following are some leading quotations alkali, 58%, £3 2s. 6d.; borax, crystals, £17 10s.; bleaching powder, soft wood, £5 7s. 6d.; hard wood, £5 17s. 6d.; chlorate of potash, 3½d.; cyanide of soda, 8d.; prussiate of potash, 5½d.; saltpetre crystals (kegs) £26; and sulphate £3 5s.—£3 15s. per ton.

LIVERPOOL.—The chemical markets have developed more activity, and although there are many complaints of the decreasing home demand, the general aspect is fairly cheerful. An improved inquiry has sprung up for sulphate of copper, helping to improve prices to £22 12s. 6d.—£22 15s. per ton for spot and early delivery, while forward positions are quoted at £23 5s. (less 5%). Sulphate of ammonia tends upwards with an improved demand, and nitrate of soda, too, has shown increased vitality. Bicarbonate of soda has experienced satisfactory demand at £5 15s. per ton in kegs. Tartaric acid shows great firmness, and little may be obtained under 12½d. Citric acid is quiet, but steady at 1s. 10½d. per lb.

GLASGOW.—The general tendency of the market has lately improved, but the development of the business has not come up to the expectations of the makers and exporters. Tartaric acid has hardened on account of the strength of the raw material causing increased forward buying. The fertiliser section has displayed more activity than for some time, though the foreign competition is still keenly felt by the Scotch makers of sulphate of ammonia. Lead products have tended upwards on account of the firm appearance of the metal market.

Metal Markets.

General sentiment in the metal trades is fairly optimistic, although dealings have not been excessive during the past two or three weeks. The main feature of the copper market has been the renewed strength displayed on the publication of the American statistics, which showed a reduction of the output of about 3,200 tons to 58,826 tons, whereas a notable increase had generally been looked for. The complete figures for the past month show the world's stocks on January 31st as 64,916 tons, which is a decrease of 5,425 tons compared with the previous month. The spot price for standard copper closes firm at £64 17s. 6d., tough and best selected are quoted at £71—£71 10s., and strong sheets at £83 per ton. Electrolytic copper has experienced improved demand, and the official quotation is maintained at £67 10s.—£68. Manufactured copper has been quiet. Tin displayed continued uncertainty. The recent rise has been so rapid, that a continuation of violent fluctuations seems likely. The highest price touched was £186 10s. for three months, but the market closed at £182 10s. America has not been taking quite so much lately, and the home trade requirements are for the time being fairly well covered. The lead market is quieter, though very firm, as the quantities arriving are moderate and the stocks in consumers' hands seem to be getting low. The Mexican position has barely improved, though the prospects for the resumption of operations at some of the mines are more hopeful. English lead is quoted at £19 12s. 6d.—£19 17s. 6d. Spelter remains lifeless, and dealers as well as outside producers have offered to sell considerably under the syndicate's prices. Zinc sheets are totally neglected.

TRADE ITEMS.

Mr. Percy Pitman of 3, Willcot Road, Acton, W., sends particulars of the Hector water motors which are made in sizes of from 1½ to 6 h.p. when working at a pressure of 80 lbs. water pressure. Particulars are also given of his improved Pelton Wheels for experimental use in technical colleges.

Messrs. Wilson and Mathiesons, Ltd., of 76, Queen Street, Cheapside, send particulars of the Wilson conditioning ovens and heaters which are fitted with sensitive balances for the conditioning of textile yarns such as wool, silk, cotton, and other like materials. Six of these ovens have recently been erected at the Bradford Conditioning House.

FINANCIAL NOTES.

Courtaulds, Ltd., which was formed to take over the business of Samuel Courtauld & Co., Ltd., with a largely increased capital recently announced the profit for the year 1913 at £474,150. It will be remembered that this firm has taken up the manufacture of artificial silk in this country under the Viscose patents with astonishing success, and ½% will be paid for the period from April 18th to December 31st, and £117,700 carried forward.

The Calico Printers' Association shows a net profit of £55,000 for the last half year. The usual half-yearly dividend on the 5% Preference Shares absorb £75,400, the required balance coming from the available reserves.

Welford's Dairies, Ltd., have paid 8% on their Ordinary Shares since 1901; the net profits have risen from £11,100 to £20,400, and it is proposed to capitalise the reserve of £70,000 in the form of 5% Cumulative Shares.

"Aktiebolaget Nya Carbo" has been registered at Ostersund with a capital of 100,000 kr. The object of the new company is the manufacture of wood distillation products.

Adalbert Vogt & Co., Chemische Fabrik G.m.b.H., has been formed at Lichtenberg, near Berlin, to carry on the business of chemical manufacturers, and to adopt an agreement with "Chemische Fabrik, Adalbert Vogt & Co." Capital, 95,000 marks. Manager, R. Selle, Lichtenberg, Berlin.

The Chemische Fabrik Dr. Bachner & Co. G.m.b.H. at Hamburg have raised the capital by 80,000 marks to 120,000 marks.

A new limited company has been formed in Berlin under the firm of "Chinoin" Fabrik chemisch-pharmazeutischer Produkte, G.m.b.H., to carry on the business of manufacturers of chemical-pharmaceutical products. Capital 20,000 marks. The managers are Dr. Georg v. Kereszety, of Budapest, and G. Cohn, chemist, of Berlin.

Dietrich's Basta Werk, G.m.b.H., in Berlin has been formed with the object of taking over the manufacturing concern of Basta Werk at Frohnau, formerly in the possession of R. Dietrich, chemist, who is to be manager of the new company. Capital, 66,000 marks.

Immendorf and Meyer, G.m.b.H., is the title of a new limited company at Cologne. The managing director is Wilhelm Immendorf. The company has been formed with the object of manufacturing chemical and technical goods and engaging in other concerns of a similar kind. Capital, 20,000 marks.

Chemische Fabrik "Lido" G.m.b.H. has been registered at Cologne with the object of carrying on the business of manufacturing and selling chemical products, especially the cleaning and polishing mixtures, pastes, powders, etc., under the trade mark of "Lido." Capital, 30,000 marks.

The celebrated Dolcoath Mine showed a reduced profit of £42,193 for 1913 against £79,107 for 1912. The value of the ore has materially reduced, although it is possible that this may recover during the current year.

NEW COMPANIES.

VASNUM CO., LTD.—Registered in London. Capital, £12,000 in £1 shares. Object: To manufacture an anti-septic fluid and powder, called Wassmuth's Sanum, to sell the same and certain inhalation machines and other apparatus, and to adopt an agreement with Marguerite B. Schorr, Catherine C. Western and Mary Frost. Registered office: 155, Brompton Road, S.W.

PLANTILLE & CO., LTD.—Capital, £1,000 in £1 shares. Object: To carry on the business of manufacturers and dealers in chemicals, oils, seeds, manures, colours and essences, etc. Registered office: 5, Lloyd's Avenue, E.C.

HYGIENIC TOILET NOVELTIES CO., LTD.—Capital, £1,000 in £1 shares. Object: To carry on the business of manufacturers of and dealers in perfumery, cosmetics, soaps, etc., and to adopt an agreement with Enrichetta B. Valli, Leo Valli and Camillo Valli.

ORCHARD REFINING CO., LTD.—Capital, £10,000 in £1 shares. Object: To carry on the business of extractors, distillers, purifiers, and merchants of and dealers in all kinds of oils. Registered office: 57, Donegal Place, Belfast.

W. A. LYNASS & CO., LTD.—Registered in Dublin. Capital, £1,000 in £1 shares. Object: To acquire and carry on the business of pharmaceutical chemists, druggists and general storekeepers, carried on by R. A. McQuilty at 5, Ann Street, Belfast, under the style of "W. A. Lynass & Co."

SENDERS, LTD.—Capital, £3,000. Object: To carry on the business of manufacturers of, dealers in, or agents for druggists' sundries, perfumery, chemicals, articles of toilet, etc., and to adopt an agreement with H. Frankiss. Private company.

OPTIME MOTOR SPIRIT SYNDICATE, LTD.—Capital, £5,000 in 4,750 ordinary shares of £1 each and 5,000 deferred shares of 1s. each. Object: To carry on the business of manufacturers, distillers, suppliers, etc., of motor spirit, naphtha, tar oils, or other hydro-carbons, benzole, chemicals, compounds, etc. Registered office: 6, Broad Street Place, E.C.

SHARE LIST.

Name of Company.	February 24th.	January 24th.
Alby United Carbide	133 1/2	127 1/2
Ditto. Pref.	133 1/2	127 1/2
Associated Portland Cement. (10)	6 1/2	6 1/2
Ditto. Pref. (10)	8 1/2	8 1/2
Babcock-Wilcox. Ord.	3 1/2	3 1/2
Ditto. Pref.	1 1/2	1 1/2
Bell's United Asbestos	1 1/2	1 1/2
Bleachers' Association. Ord. ..	1 1/2	1 1/2
Ditto. Pref.	1 1/2	1 1/2
Borax Consolidated. Pfd. (5) ..	5 1/2	5 1/2
Ditto. Defd.	1 1/2	1 1/2
Ditto. Pref. (10)	11 1/2	11 1/2
Bradford Dyers	1 1/2	1 1/2
Ditto. Pref.	1 1/2	1 1/2
British Oil and Cake. Ord. ..	1 1/2	1 1/2
Brunner Mond. Ord.	4 1/2	4 1/2
Ditto. 7% Pref. (10)	14 1/2	15 1/2
Bryant and May. Pref.	2 1/2	2 1/2
Calico Printers	1 1/2	1 1/2
Ditto. Pref.	1 1/2	1 1/2
Castner Kellner	2 1/2	2 1/2
Commercial Salt. (2/-)	8/-	8/-
Crossley & Sons. (2)	1 1/2	1 1/2
Ditto. 5% Pref.	4 1/2	4 1/2
Eastman Kodak. (\$100)	530	580
Eley Brothers	1 1/2	1 1/2
Fraser and Chalmers. (£3)	1 1/2	1 1/2
Gas Light and Coke. (S)	101	103
Ditto. 4% Pref. (S)	95	98x.
Greenwich Lino. (1/2)	1 1/2	1 1/2
Harrison and Crossfield. Pref. ..	1 1/2	1 1/2
Imperial Continental. (S)	174	179
Ditto. 3 1/2% Debenture (S) ..	83 1/2	85 1/2
India Rubber Co. (10)	11	12
International Salt	4/-	5/-
Ditto. Pref. (5/6 pd.)	1 1/2	1 1/2
Lever Brothers. 1st Pref. (10) ..	11 1/2	11 1/2
Lister & Co. Ord.	1 1/2	1 1/2
Mappin & Webb. Ord.	1 1/2	1 1/2
Neuch'el' Asphalt. (10/-)	9 1/2	9 1/2
Nobel Dynamite. (10)	17 1/2	18 1/2
Ditto. Bearer (10)	17 1/2	18 1/2
Ditto. 5% Pref. (10)	11	12
Pears, A. and F. Ord.	1 1/2	1 1/2
Ditto. 6% Pref. (10)	12 1/2	12 1/2
Price's Candle. (16)	36 1/2	38 1/2
Rosario (5)	9 1/2	9 1/2
Salt Union. (4)	1 1/2	1 1/2
South Metropolitan 4% Standard (S)	110	112x.
Ditto. 3% Debenture (S)	73	75
United Alkali. (10)	7 1/2	8
Ditto. Pref. (10)	7 1/2	8
Val de Travers	1 1/2	1 1/2



THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY W. P. DREAPER, F.I.C.

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

VOL. III. No. 4.

APRIL, 1914.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
" " " " " " " " " " " "

Technical Appointments.

With reference to Mr. Wickenden's remarks in the February number of this journal, and the article by Mr. Kershaw in the March one, we have received a communication, from which we extract the following:—

"Mr. Wickenden's letter, in your February number, on 'The Fundamental Weakness of the Science College,' contains much that is very sound and deserving of consideration by those who are interested in the progress of higher education in science. Your leader in the same issue appears to answer only his opening sentence and, indeed, there was little else to find fault with in his views, which were both frank and courageous.

"Until our system of education is remodelled, students must do the best they can under teachers who can conduct research but cannot teach, and teachers who can teach but do not undertake research.

Hugh Miller said:—

"Almost all the men who ever taught a few pupils, with a great many more who never taught any, deem themselves qualified to say something original on education; and perhaps few books of the kind have yet appeared, however mediocre their general tone, in which something worthy of being attended to has not actually been said. And yet, though I have read not a few volumes on the subject, and have dipped into a great many more, I never yet found in them the sort of direction or encouragement which, in working out my own education, I most needed. They insisted much on the various modes of teaching others, but said nothing—or, what amounted to the same thing, nothing to the purpose—on the best mode of *teaching one's-self*."

"After all, in chemistry, as in most other callings, have not those succeeded most, who have taught themselves? Many have had the good fortune to come under good teachers, but the best of teachers have not always the good fortune to find apt pupils.

"In a Presidential Address to the Institute of Chemistry, Mr. David Howard (whom you quoted in February), referred to the following sentences which appeared in a then recent article in the Press:—

"Although in this country there have never been wanting capable chemists able to carry on and extend the manufacture of colouring matters, there has been a complete lack of understanding on the commercial side of the complex requirements of the industry, and complete lack of sympathy between the capitalist and the scientific worker. The failure must be credited to our universities, and to our faulty system of higher education—to our inbred Philistinism."

"Mr. Howard agreed that there was much truth in the first sentence, but could not see how the second was a deduction from the first. Every decade did not bring a Hofmann, but while there was every evidence that the chemists were improving, how could the teachers be blamed? Every Hofmann could not produce, but had to find a Perkin. The teachers had not much choice in the selection of their raw material, and it was with the taught that the responsibility lay of showing themselves worthy of their teachers.

"The teaching of science is a modern profession; no facilities for the practical teaching of chemistry existed until well into the nineteenth century; and the progress of the science has been so rapid that it is impossible in the ordinary college course to provide a student with more than a fundamental basis on which to build his experience.

"How much of the time of a professor is spent in the work of organisation, attendance at meetings—at college, university and societies—the conduct of examinations, and so forth? There is, in many cases, little time left to do more than deliver their allotted courses of lectures, and supervise in a general way the work of the junior staff. So much in defence of the professors; and now to consider the lecturers and demonstrators, in many cases no less overworked, with classes far too large and salaries far too small!

"Sir William Tilden, speaking at a conference some eighteen months ago, gave the opinion that:—

"The man of ability *only* should be encouraged to take up chemistry, but to what can he look forward? Suppose he enters the teaching profession as a chemist only (not as a schoolmaster), he can begin, if he is lucky, with a Junior Demonstratorship in a college, and may ultimately reach a

Professorship. The number of Professors whose stipend is £1,000 and upwards—there is none over £1,500—does not exceed in this country about half a dozen, consequently the chances are small. He may become a teacher in a technical school and, there, rise in time to be the head of a department, with perhaps £400 or £500 a year; or he may take to teaching science in a secondary school, with prospect of making a living if he is willing to teach other subjects, such as mathematics and physics, or even subjects of a literary or general character. From this mixed employment, only one here and there is strong enough physically to emerge from the exhausting burden of routine in a fit condition to follow purely scientific work.

“The great defect in the teaching career, for the chemist, is not so much the small remuneration which is offered at the outset, but the poverty of the outlook. At twenty-five to thirty, a man wants to marry, and the salaries represented by £150 or less do not enable him to do so.

“The consequence is that many become disheartened and stick fast to routine, earning precarious additions to their small official incomes by examination and literary work, or they throw it up at the first opportunity of escape.”

“Turning now to Mr. Kershaw's article (in the March number) it is certain that many will differ from his statement that ‘the best chemists do not enter the industrial world,’ and will hold that as good men go into practice and into industry as those who remain in the colleges to teach. No longer are the principal advances in chemical science and its applications entirely evolved from the universities and colleges. The work of professional chemists, apart from professorial chemists, is constantly in evidence in our journals and, except possibly in the higher theoretical domain, the chemists in practice are mainly for progress in industrial chemistry. Consider the work of agricultural chemists and public analysts, of metallurgical, mining and engineering chemists, and of chemical engineers.

“The pity is that promising students are retained for teaching. It were far better for them to see something of the work-a-day world and the applications of their science even when they are finally selected to take the share in the former.

“The outlook for chemists of the right type is decidedly improving. Their position in industries is almost entirely dependent on personal ability, and many young chemists are steadily rising to the control of works or of important departments in large concerns. “Testing machines and laboratory hacks’ there will be; they are necessary, but those who are content to remain so have mainly themselves to blame. The manufacturers are not so much in fault as Mr. Kershaw supposes. They realise more and more that chemists of a higher order can be had by paying for them. In many cases they do offer and pay substantial retaining fees, and men of the right type are to be had under such conditions. The young chemist who wants to get on must have real ability and ambition. A combination of character and competence is necessary in every case.

“Mr. Kershaw may know only one chemical company in which science has been adequately

recognised in the appointments of the board of directors, but to any one who thinks for a few moments of men who are directors of important chemical concerns, a string of names will occur of men who are not only sound business men but trained and able chemists.”

Surface Tension.

We publish in this number the first of a series of articles on “Surface Tension and Surface Energy, and their Influence on Chemical Phenomena,” by Dr. R. S. Willows and E. Hatschek. The subject is one to which chemists, physiologists and biologists have all been forced to pay increasing attention in late years, while it must at the same time be admitted that many of them become somewhat vague when they have to consider surface tension and surface energy as a factor in the phenomena observed.

This is no doubt due to the circumstance that information on the subject cannot be obtained in a form easily applied, even from the big text books of physics, which dwell largely on aspects of the subject which lend themselves to highly complicated mathematical treatment.

In the present series the authors will endeavour to emphasise the connection between surface tension and various other properties of materials, which are likely to interest the chemist, and to indicate how surface energy may become an important, and occasionally a decisive factor, in phenomena that cannot be satisfactorily explained on a chemical basis alone.

NOTES OF MEETINGS.

Chemical Society.

April 2nd.

Society of Chemical Industry.

LONDON SECTION.—April 6th.

Society of Public Analysts.

April 1st. R. R. Tatlock and R. T. Thomson, “On Damage caused to Vegetation by Sulphurous and Sulphuric Acids in the Atmosphere.” J. McCrae, “Abnormal Refraction of Milk Serum.” C. A. Mitchell, “Water of Dorton Spa.”

Royal Institution.

April 3rd, at 9 p.m. Professor Sir J. J. Thomson, “Further Researches on Positive Rays.”

April 4th, at 3 p.m. Professor Sir J. J. Thomson, “Recent Discoveries in Physical Science.”

April 6th, at 5 p.m. General Meeting.

Royal Photographic Society.

April 21st. Ordinary Meeting.

Institution of Civil Engineers.

April 7th and 21st.

Institution of Mechanical Engineers.

April 23rd. Anniversary Dinner.

April 24th. General Meeting.

SOME STEREO-CHEMICAL ASPECTS OF RESIDUAL AFFINITY.

By PROFESSOR G. T. MORGAN, D.Sc. (LOND.) A.R.C.Sc., F.I.C.

THE extraordinary success, which in the field of organic chemistry has attended the acceptance of the doctrine of the quadrivalent carbon atom has favoured the view that the valencies of other elements, even when these exhibit great variability in their habits of combination, can also be expressed as exact multiples of the valency of the generally adopted standard, hydrogen. If, however, the valency of the latter element is taken as the unit, there arises the practical difficulty that in many instances the hydrides of the elements are either unknown, ill-defined, or non-volatile, and hence quite unsuitable for the purpose of fixing the valency of these elements. The halogens, however, enter more generally into combination with metals and non-metals, and chlorine, or preferably fluorine (Friend, *Chem. Soc. Trans.*, 1908, 93, 262), is generally taken as equivalent to hydrogen in determining valency, or rather that portion of the total chemical affinity of an element which can be expressed as an exact multiple of the combining power of the standard element. A glance at the following series of compounds will show that the integral valency of an element as manifested towards hydrogen is not always identical with that shown in its combination with fluorine.

Principal Valency and the Periodic Classification.—The general principle underlying the periodic classification of the elements has proved sufficiently elastic to admit of the inclusion into the scheme of the non-valent argonides, and the more resolute upholders of Mendeleef's great generalisation no longer hesitate to place the "noble gases" in the eighth vertical series as a natural family of elements alternating with that of the noble metals. Turning now to the elements exhibiting integral or principal valency a consideration of the periodic scheme shows that only in the first four vertical series is the hydrogen valency identical with that manifested by the valency towards fluorine.

	1.	2.	3.	4.	5.	6.	7.	8.
hydrides	LiH	CaH ₂	(BH ₃) ₂	CH ₄	PH ₃	SH ₂	IH	—
fluorides	LiF	CaF ₂	BF ₃	CF ₄	PF ₅	SF ₆	IF ₇	OsF ₈
oxides	Li ₂ O	CaO	(B ₂ O ₃) _x	CO ₂	(P ₂ O ₅) ₂	SO ₃	I ₂ O ₇	OsO ₄

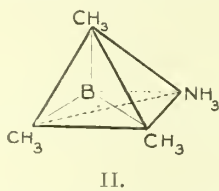
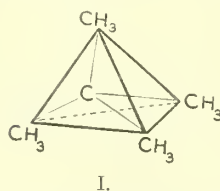
In the hydride series the maximum valency is reached at the fourth term with carbon and silicon as tetrads. The fluorine valency, however, continues to increase and the recent production of osmium octafluoride by Ruff and Tschirch (*Ber.*, 1913, 46, 936) confirms the view that the principal valency of the elements may attain a maximum value of eight, even although this ideal is reached in comparatively few instances. Confirmatory although less unequivocal evidence is afforded by the typical oxides.

Residual Affinity and the Periodic Classification.—It can scarcely be maintained to-day that integral or principal valency measured in terms of hydrogen or fluorine, represents the sum total of the available chemical affinity of an element. The term "residual affinity" was first employed by Pickering in 1885 to indicate the chemical affinity remaining after the integral valency of an element has been satisfied. This conception, which was further developed by H. E. Armstrong (art. "Chemistry," *Encyclopædia Brit.*, 10th edition, 1902, p. 717) is closely akin to that implied by Werner in the term "Nebenvalenz," or auxiliary valency. The differences observed between the hydrogen and fluorine valencies exhibited by elements of the series five to eight, would seem to indicate that, in the case of these elements of variable combining power, the residual affinity might be expressed as the arithmetic difference between the two principal valencies. Nitrogen and phosphorus in their common hydrides RH₃ have a potential valency of five, and as only three units of valency are being exerted, the compound has a residual affinity of two. Similarly, the water molecule, OH₂, has a residual affinity of two or four according as to whether the maximum valency of oxygen is regarded as four or six. It is in the highest degree improbable that residual affinity can always be expressed as an integer. In the amine-oxides N(CH₃)₃:O and phosphine oxides P(C₂H₅)₃:O the maximum group valencies of nitrogen and phosphorus are displayed; nevertheless these compounds exhibit considerable residual affinity and combine additively with acids forming simple and double salts.

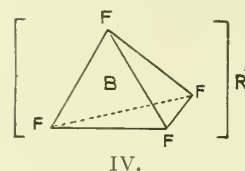
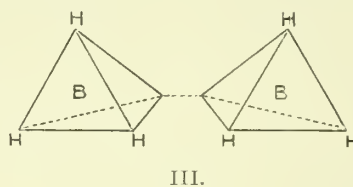
Residual Affinity and Molecular Configuration.—In the fourth series the hydrogen and fluorine valencies are identical and carbon tetrafluoride is an inert compound resembling the paraffins. Silicon tetrafluoride, however, manifests a well-marked residual affinity in combining with hydrogen fluoride and the metallic fluorides to form the acid H₂SiF₆ and its salts, M'₂SiF₆. The majority of the succeeding elements of the fourth vertical series yield analogous compounds of which the following may be regarded as types: K₂ZrF₆, (NH₄)₂Ce(NO₃)₆, (NH₄)₂SnCl₆, (NH₄)₂PbCl₆. The recurrence of the number 6 in these compounds is very significant.

Another noteworthy example of residual affinity is afforded by the element boron which in many respects is closely allied to carbon and silicon. In its ordinary binary compounds this element is consistently trivalent, e.g., BF₃, BCl₃, (B₂O₃)_x, etc. But if this trivalency represented the whole available chemical affinity of boron these substances should be distinguished by a chemical inertness similar to that of the paraffins and their haloid derivatives.

On the contrary the boron halides are very reactive, the fluoride combining with hydrogen fluoride forming fluoboric acid HBF_4 (IV.). The boron alkyls behave similarly, E. Frankland, their discoverer (*Annalen*, 1862, 124, 129; *Phil. Trans.*, 1862, 152, 167), showing that boron trimethyl combines additively with ammonia and potassium hydroxide to form respectively $\text{B}(\text{CH}_3)_3$, NH_3 and $\text{B}(\text{CH}_3)_3$, KOH . It is worth while contrasting the reactivity of boron trimethyl with the chemical inertia of its analogue, tertiary pentane $\text{C}(\text{CH}_3)_4$. The inactive character of the paraffins is generally explained in terms of the theory of integral valencies and it is assumed that the combining power of the carbon chain is completely satisfied by hydrogen so that no units of free valency are left over to form additive compounds. Nevertheless the paraffins do undergo substitution, and as it is impossible to conceive how this operation can occur without the previous formation of an additive compound, there must be some residual affinity available for this initial process. A complete explanation of the inertness of the paraffins must account for the instability of the elusive additive compounds the existence of which precedes the bromination of ethane or the nitration of hexane. The non-existence of isomerides of the type Ca_2b_2 and the resolution into optically active components of substances, Cabcd, containing four dissimilar radicles attached to carbon justify the view that in organic compounds in general the four radicles in association with a carbon atom adopt the most symmetrical arrangement and are situated at the vertices of the tetrahedron inscribed in the sphere of influence of this atom (I.). The conditions are otherwise in the case of boron trimethyl. Here a symmetrical arrangement of alkyl groups round the boron sphere is impossible, but this element possesses sufficient residual affinity to initiate the formation of additive compounds in which a symmetrical tetrahedral distribution of the associating units is possible, thus conducing to the stability of the product (II.).



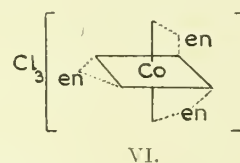
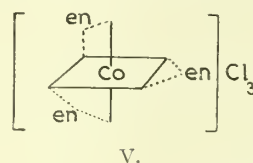
residual affinity of boron to form a more stable compound (III.) containing two tetrahedral boron atoms.



$\text{R}'\text{BF}_4$ where $\text{R}' = \text{H}$, or Na or K

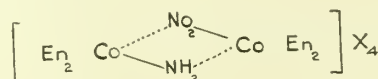
In the case of boron and carbon the most favoured configuration is the tetrahedron corresponding with the co-ordination number 4.

Each carbon atom in a paraffin is already a centre of tetrahedral symmetry and, as the production of additive compounds would destroy the existing symmetry, these substances are formed only in exceptional circumstances and have but a very transitory existence. The chemical inertia of the paraffins is to be ascribed to their symmetrical molecular structure (I.), arising from the quadrivalency of carbon rather than to the absence from this element of any degree of residual affinity. In other cases, as for example with silicon and its homologues, the co-ordination number 6 is very prevalent. After many years engaged in the patient study of the co-ordinated compounds of cobalt, chromium, and allied elements, Werner has succeeded in proving that in the co-ordination complexes containing six associating units, these units adopt the most symmetrical arrangement, and are situated at the vertices of the regular octahedron inscribed in the sphere of influence of the central atom.



$\text{en} = \text{C}_2\text{H}_4(\text{NH}_2)_2$.

The resolution of compounds such as the salt $[\text{Co}, 3\text{C}_2\text{H}_4(\text{NH}_2)_2]\text{Cl}_3$ into two optically active enantiomorphs (V. and VI.) establishes the doctrine of the octahedral co-ordination complex as firmly as that of the tetrahedral carbon atom (*Ber.*, 1911, 44, 1887, 2445, 3132, 3272; 1912, 45, 121, 433, 865, 1228, 3061, 3281).



$\text{X} = \text{Cl}, \text{Br}, \text{CNS};$
 $\text{En} = \text{C}_2\text{H}_4(\text{NH}_2)_2$.

In the article already cited Armstrong contended that the same forces were active in residual affinity, and in ordinary affinity (integral valency), the differences being in quantity rather than in quality; and Werner has quite recently demonstrated this point experimentally by showing that the complex salt (VII.), can exist in four different

Equally remarkable are the results recently obtained in the investigation of the boron hydrides (hydroborons) which is now being resolutely undertaken by Stock and his collaborators (*Ber.*, 1912, 45, 3539; 1913, 46, 1959). Although it would be premature to discuss the theoretical bearing of all the compounds which have been isolated the evidence available warrants the belief that the existence of these complex products will not be easily explained on any theory of integral valency. The simplest theoretically possible hydroboron, BH_3 , is not forthcoming, and the least complex hydroboron, B_2H_6 , which is produced from B_4H_{10} , probably arises from a polymerisation of two extremely reactive and unstable BH_3 radicles uniting by virtue of the

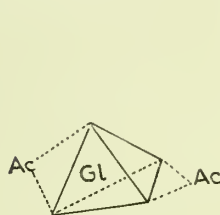
forms corresponding with (dextro- and lævo-rotatory and racemic tartaric acids and mesotartaric acid).

This relation could hold only if in the co-ordination complex the attractions between the cobalt atoms and the associating radicles were of the same order, irrespective of whether these radicles were originally attracted by virtue of principal valency (continuous lines), or of residual affinity (dotted lines) (*Ber.*, 1913, 46, 3676).

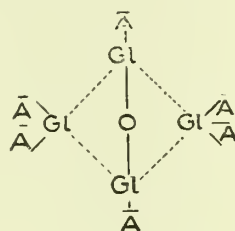
Other Types of Co-ordinated Compounds.—

Among carbon compounds we find many varieties of open chain and closed ring derivatives, and it is to be expected that a further study of co-ordinated compounds will reveal diverse types of co-ordination complexes. Glucinum yields an acetylaceton

derivative (VIII.) $\text{Gl} \left[\begin{array}{c} \text{O} : \text{CMe} \\ \text{O} : \text{CMe} \end{array} \right] \text{CH}_2$ corresponding in structure with the boron compounds III. and IV., but it also furnishes a remarkable basic acetate $\text{Gl}_4\text{O}(\text{CH}_3\text{CO}_2)_6$ (IX.), which is undoubtedly co-ordinated, but in a different manner. These two compounds may be represented by the following formulæ:—



VIII.



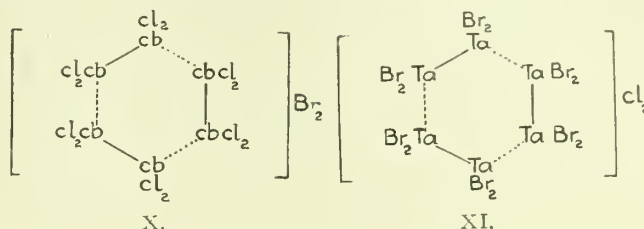
IX.

Among glucinum compounds the co-ordination number is generally four, corresponding with the tetrahedron, and it is plainly seen that in the two foregoing formulæ each glucinum atom is a centre of tetrahedral symmetry.

The lowest chloride of molybdenum and the corresponding bromide exhibit a noteworthy type of co-ordinated complex. Molecular weight determinations give the formulæ as Mo_3Cl_6 and Mo_3Br_6 , but only one-third of the halogen present is ionisable; electrolysis in 96% alcohol shows that the cations are $(\text{Mo}_3\text{Cl}_4)^+$ and $(\text{Mo}_3\text{Br}_4)^+$. The hydroxides $(\text{Mo}_3\text{Cl}_4)(\text{OH})_2$ and $(\text{Mo}_3\text{Br}_4)(\text{OH})_2$ have been prepared and the corresponding halides $(\text{Mo}_3\text{Cl}_4)\text{Br}_2$ and $(\text{Mo}_3\text{Br}_4)\text{Cl}_2$ (*Zeitsch. anorg. Chem.*, 9, 406). Here we have probably a complex of two molybdenum and four halogen atoms surrounding a central molybdenum atom, an arrangement which might have the octahedral symmetry (V. and VI.) or a three-membered ring structure resembling a trimethylene (Koppel, *Zeitsch. anorg. Chem.* 1912, 77, 294).

The cyclic configuration is even more plainly suggested in the remarkable products recently obtained by the reduction of tantalum and columbium pentachlorides and having the following formulæ: $\text{Cb}_6\text{Cl}_{14}, 7\text{H}_2\text{O}$; $\text{Ta}_6\text{Cl}_{14}, 7\text{H}_2\text{O}$; $\text{Ta}_6\text{Br}_{14}, 7\text{H}_2\text{O}$. In these compounds only one-seventh of the halogen is ionisable, the remainder being present in the complexes $(\text{Cb}_6\text{Cl}_{12})^+$, $(\text{Ta}_6\text{Cl}_{12})^+$ and $(\text{Ta}_6\text{Br}_{12})^+$. The corresponding hydroxides and mixed halide

salts have the following formulæ: $(\text{Cb}_6\text{Cl}_{12})^+(\text{OH})_2^-$; $(\text{Ta}_6\text{Cl}_{12})(\text{OH})_2$; $(\text{Ta}_6\text{Br}_{12})(\text{OH})_2$; $(\text{Cb}_6\text{Cl}_{12})\text{Br}_2, 7\text{H}_2\text{O}$ and $(\text{Ta}_6\text{Br}_{12})\text{Cl}_2, 7\text{H}_2\text{O}$. The co-ordination complexes present in these substances suggest a comparison with cyclohexane.



Here again, as in the case of Werner's compound (VII.) there is probably a smoothing out of the quantitative difference between principal and auxiliary valencies. It will be also noticed that each atom of columbium or tantalum is a centre of tetrahedral symmetry, and that the whole cyclic complex has a residual affinity approximating in value to two units of valency (Chapin and Harned, *J. Amer. Chem. Soc.*, 1910, 32, 323; 1913, 35, 1078).

THE COMPULSORY WORKING OF PATENTS.

THE Patents and Designs Act, 1907, consolidated and amended the statute law as embodied in several Acts dated between 1883 and 1902, and it altered considerably the law as to the duties and rights of patentees and the machinery for dealing with questions arising in connection with patents. The Act came into force amidst a flutter of excitement, caused in particular by one section. That section was No. 27, and is generally spoken of as the compulsory working section. It reads as follows:—

"1. At any time not less than four years after the date of a patent, and not less than one year after the passing of this Act, any person may apply to the Comptroller for the revocation of the patent on the ground that the patented article or process is manufactured or carried on exclusively or mainly outside the United Kingdom.

"2. The Comptroller shall consider the application, and, if after inquiry he is satisfied that the allegations contained therein are correct, then, subject to the provisions of this section, and unless the patentee proves that the patented article or process is manufactured or carried on to an adequate extent in the United Kingdom, or gives satisfactory reasons why the article or process is not so manufactured or carried on, the Comptroller may make an order revoking the patent either—

"(a) Forthwith; or

"(b) After such reasonable interval as may be specified in the order, unless in the meantime it is shown to his satisfaction that the patented article or process is manufactured or carried on within the United Kingdom to an adequate extent;

" Provided that no such order shall be made which is at variance with any treaty, convention, arrangement, or engagement with any foreign country or British possession.

" 3. If within the time limited in the order the patented article or process is not manufactured or carried on within the United Kingdom to an adequate extent, but the patentee gives satisfactory reasons why it is not so manufactured or carried on, the Comptroller may extend the period mentioned in the previous order for such period not exceeding twelve months as may be specified in the subsequent order.

" 4. Any decision of the Comptroller under this section shall be subject to appeal to the Court, and on any such appeal the Law Officer, or such other counsel as he may appoint, shall be entitled to appear and be heard."

The possibility of obtaining revocation of a British patent on the grounds set out in the section was an absolutely new feature in British patent law, and the introduction of such a feature was held by many to be a great step in advance, and one likely to impart a great impetus to British trade and manufacture. Unfortunately the section and the Patent Rules which regulate the procedure thereunder before the Comptroller brought into existence a procedure which was afterwards recognised by those in a position able to form an unbiassed opinion as open to serious abuse, and calculated to place a patentee in a very invidious position. The procedure was as follows: The section gives any person the right to apply for revocation of a patent on the grounds set forth, and the Patent Rules simply required the presentation of an application alleging that the invention was worked, wholly or mainly, abroad, and without the lodging of any evidence or statement by the petitioner in support or proof of his allegation. The patentee was then called at once to state whether or not the allegation was true, and, if untrue, to prove to what extent and where the invention was worked in the United Kingdom. To give such a proof as was required would in many cases necessitate the disclosure by the patentee of information which might be very damaging to him in his business. As an application for revocation can be lodged by any person, it will be seen that it was open to a trade rival to file an application and compel a patentee to disclose a great deal of information which was not available otherwise. As soon as this information had been obtained the applicant could withdraw the petition and gracefully retire from the matter. It will be appreciated from what has been said that the patentee was placed at the mercy of the world. This was the position of affairs until a petition for revocation (*In re Hatschek*) was taken to appeal. The appeal was heard by Mr. Justice Parker (now Lord Parker), who, in delivering judgment, seized the opportunity of animadverting on the procedure that had been adopted and of laying down what it should be in the future. The learned judge pointed out the danger and inadvisability of putting into the hands of a common informer the power of coming before the Comptroller and alleging, without any proof whatever and without any *prima facie* case, that a

patentee was not working his patent adequately in this country, but that he was working it abroad. Mr. Justice Parker ruled that an applicant for revocation ought to be in the same position as even a common informer and required to set forth a case requiring an answer. This judgment resulted in an immediate amendment of the procedure under section 27 and an applicant for revocation has now to show that he has a *prima facie* case before the matter is allowed to proceed further, and the patentee is called on to prepare his defence and refute, if he can, the case presented by the applicant.

This amended procedure, which, it is submitted, would have the support of all right-minded and fair-thinking men, as equitable, does not commend itself to, at least, the Patents, Trade Marks and Designs Section of the Manchester Chamber of Commerce, and they have been working for some time past for the restoration of the old state of affairs. In pursuance of their crusade they put forward at the meeting of the Associated Chambers of Commerce, held in Antwerp in September, 1913, a resolution in the following words:—

" That in view of the fact that Mr. Justice Parker's comments in the *Hatschek* case in the year 1909, as to the extent of the *onus* devolving upon any applicant who seeks revocation of a patent for non-working under section 27 of the Patents and Designs Act, 1907, have deprived that section of its effectiveness, this Association urges upon His Majesty's Government to amend the Act in such terms as will place the burden of proof on the patentee, an effect which was the object of those who drafted the Act in 1907."

This resolution was not adopted, and an amendment deferring further consideration of the question until the meeting of the Associated Chambers in March, 1914, was proposed and carried.

We admit that to the general public compulsory working appears to be an ideal measure, as enforcing manufacture and the employment of labour in our own country. But one must not overlook the fact that what is likely to be gained by enforcing manufacture in this country is almost certain to be lost by retaliatory measures enforcing manufacture by British subjects in foreign countries and in the colonies. If our Government agrees to the proposals of the Manchester Chamber and adopts the resolution quoted, which was passed at the March meeting of the Associated Chambers, it will make the law governing compulsory working of patents more drastic, and other countries and the colonies will retaliate and stiffen up their provisions, as some have already done. These retaliatory measures raise a very much more serious question. What will be the result? If the invention be "mainly" carried on in this country, the patentee will lose his rights in the other countries. If "mainly" carried on in one of the other countries, or "mainly" carried on in two or more countries, he will lose his British and other foreign rights. Consequently, if all foreign countries adopt the compulsory working clause of this country, it will practically amount to an estoppel to the obtaining or maintenance of foreign patent rights.

SCIENTIFIC SOCIALISM—OR SYNDICALISM?

By MARTIN O. FORSTER.

Is Professor Armstrong's diatribe in the March number intended as a serious contribution to the cause of international peace and scientific goodwill towards men?

The spectacle of the Professor, modestly attired in the white robe of "toleration," standing on the steps of the "English Imperial Chemical Clearing House," pouring impartially on Germans, Americans or fellow-countrymen caustic gibes couched in badly constructed English, but always "with breadth of view and the Christian spirit," certainly does not suggest it.

For an old student of the Professor, particularly one who, like myself, admires profoundly the remarkable service he has rendered to our science, it is difficult to read his article with detachment; but in trying to place myself in the position of a foreigner, or of an English chemist who does not realise that Dr. Armstrong is just as much an institution in our little circle as is Mr. Bernard Shaw in the greater world, I am forced to the conclusion that his present effusion, like the operations of militant suffragettes, is calculated to do more harm than good to the cause which he professes to have at heart.

Consider first his remarks on the linguistic shortcomings of Germany and America. The misuse of an active verb as a passive one is admittedly regrettable, but it is an error which Germans themselves may be trusted to rectify more quickly by persuasion. It is an example, simply, of laboratory slang, correction of which is one of the purposes to be held in view by a careful editor, whose action, if applied to the Professor's own productions, would doubtless be heartily resented by him. The unusual spelling of "oxide" and "sulphide" adopted in America is certainly jarring to English sentiment, and is not even phonetic, but surely the Professor, who has travelled in America and must be superficially, at least, conversant with American psychology, knows that this error is merely the outcome of exuberant enthusiasm for a new cause, and will right itself—has, indeed, according to his own statement, already righted itself—as a result of more careful thought. What is to be gained in a matter of this kind by the policy of the big stick? Could we have a more apt example of the major power of the olive-branch than the recent pronouncement of President Wilson concerning the Panama tolls? Here an untenable attitude had been strongly assumed by certain American groups, an attitude unanimously condemned by the European nations, who have acted, however, with conspicuous self-control; would not the Professor admit, on reflection, that the action of the President towards the proper observance of treaty rights has been greatly facilitated by that self-control?

This latest outburst of Professor Armstrong must appear to those who do not know him like the "shan't play" attitude of a schoolboy. His abuse of the publishing branch of the Chemical Society's

activities must suggest to many that some of his own papers have needed editing, and a careful study of his article would confirm such people in the suspicion that those papers richly deserved it. I will not burden readers with a list of *errata* which anyone interested can compile for himself, but it is surely a crystallised mockery that the author of such an article, as printed, should trounce without mercy his companions in error; in this respect the Professor is not merely living in a glass house, he has defiantly taken up his residence in a crystal palace.

Whilst casting about for an explanation of Professor Armstrong's acrid condemnation of the manner in which chemical publications are conducted, I have been led to engage in a modest little piece of historical research, the result of which, in my belief, clears the situation like mist before the rising sun. Taking at random two of his papers from "the palmy days" about forty years ago, I studied them carefully, and found them to be written in the most precise English, well worthy of imitation, not only by those "who are but learning to work and educating themselves rather than adding to the sum of knowledge," but even by their distinguished author himself. In the papers examined, I never found a sentence beginning with "and," whilst "but," when used in the course of a sentence, was always preceded by a comma or semicolon. These early efforts were unsullied by such matriculation blunders as "to know whether horse or cart come (*sic*) first," and in no case did a preposition terminate a sentence. Whence there emerges this fact, Dr. Armstrong seemingly does not offer to publishing bodies the same class of literary material which the Chemical Society published in his name forty years ago. It follows unerringly that, if the Professor holds up the late Mr. Henry Watts as a model editor, a course with which doubtless all will agree, it is the height of contradiction on his part to castigate modern editors for preferring the style which Mr. Watts preferred. If the Professor "can imagine the shades of Liebig, Kolbe and Volhard being tormented by the reading of such passages from the *Annalen*," it might be worth his while in imagination to confront the shade of "that prince of editors, Henry Watts," with "A Move towards Scientific Socialism"; should he do so I should expect to find that, even if "the hand was always that of the friend," the blue pencil was, nevertheless, found to be firmly grasped therein.

The article appeals for a fusion of publishing interests by which all abstracts appearing in the English tongue may be pooled, and issued under the auspices of a single organisation. I am in full agreement with the Professor as to the desirable aspects of such a scheme, but the change in question cannot be accomplished by the waving of a wand, especially when that wand takes the uncompromising form of a bludgeon. Reorganisation of this character

is one of the most difficult non-chemical problems confronting chemists, and, much as I have always been attracted by the prospect, I am not yet convinced that it is practicable. The reason for this doubt lies in the fact that our societies have developed along different lines and have become separate entities, not so much by the "illiberal and autocratic action" of any party as by the separate appeals which these societies make to separate temperaments. Some chemists become, partly by temperament, partly by environment, more deeply interested in problems of atomic or molecular structure and the craftsmanship demanded by such problems; they turn by instinct to the pages of the Chemical Society's publications, which have gradually assumed the form which appeals to them because the predecessors of those chemists, including Dr. Armstrong and "that prince of editors," being also interested in such problems, helped to give those pages that form. Other chemists, whilst recognising the necessity of such work, are more sympathetic by temperament towards the practical application of principles to industry; the papers and abstracts which appeal to them are those in which such applications play a prominent part. It is because so many chemists possess this intellectual instinct that a different society, with its own journal, has been developed by workers who may be just as scientific as the former class, but whose science takes a slightly different form; those chemists who combine both turns of mind are not embarrassed by this condition of affairs, they apply themselves to each journal in whichever sequence pleases them. It is quite debatable whether the obliteration of these differences, supposing it were possible, would not operate unfavourably on the development of our science, by forcing all chemists into one mould. If this is what the Professor means by scientific socialism, his argument exposes itself to the same objection as political socialism. Moreover, the machinery he proposes for the control of this new publishing body, namely, "open meetings, quarterly at least, at which its actions could be challenged and rectified," is unworkable, because preparation for publication is much too detailed a process to be conducted on those lines; it would be just as sensible to place the control of an Atlantic liner in the hands of a committee of passengers. When the Professor declares, quite rightly, "the world is full of human nature, and human nature is proverbially selfish and narrow, if not blind," there floats before me an image of him defending the language of his article at a quarterly meeting. As a means for increasing the attendance at our meetings it would certainly serve a purpose, but I question whether he would be quite so much in love with the system then as he claims to be now. Co-operation, which he demands, would have to be genuine co-operation, not merely making the other Fellow do what he wants.

Difference of temperament is not the only obstacle to the proposal. There is the geographical difficulty involving delay which, if my recollection serves, was one reason for the breakdown of the negotiations with Professor Noyes in 1905. The

question of finance is another, because the councils of the various societies may be pardoned for looking askance at action which might diminish enormously the membership of those societies. But let the Professor take heart of the International Association of Chemical Societies, the activities of which may have escaped his notice owing to "the decay of the reading habit and all that this involves." If he turns to p. 331 of the *Proceedings of the Chemical Society*, 1913, he will find that a commission has been appointed to report at the next meeting of Council on the publication of an International Journal of Abstracts in three languages. I am confident that all chemists will sympathise with the deliberations of this commission, and I appeal to Professor Armstrong to treat his fellow practitioners with toleration and the Christian spirit at least until the pronouncements of that commission have been published.

We much regret that in an article written by Professor Henry E. Armstrong which appeared in the March number of this Journal words were used which have been understood to reflect very seriously upon the professional ability of Dr. J. C. Cain, the Editor of the Journal of the Chemical Society.

There was no intention to reflect upon Dr. Cain's professional ability or make any such implication and we unreservedly admit that there is no foundation in fact for any such imputation upon that gentleman, and we deeply regret that any words capable of that construction should have appeared in our Journal.

W. P. DREAPER.

J. & A. CHURCHILL.

We also have pleasure in publishing the following:—

55, GRANVILLE ROAD,
LEWISHAM, S.E.
27th March, 1914.

DEAR DR. CAIN,—I much regret that in an article written by me, and published in the last month's number of the CHEMICAL WORLD, words have been used by me which have been understood to reflect upon your professional ability.

I had no intention of reflecting on your ability or personal character, and had in my mind—as I think is apparent from the article—merely wide general issues without reference to any personal qualifications or disqualifications. But it seems my article is capable of misinterpretation, and has been misunderstood by you and others, and I am quite ready to express my regret for any words capable of being regarded as an imputation upon you.

I trust you will accept this apology in the spirit in which it is offered, and as the best amends which it is in my power to make for the annoyance which I have unintentionally caused you.

I am, yours faithfully,

HENRY E. ARMSTRONG.

DR. J. C. CAIN,

24, Aylestone Avenue,
Brondesbury Park, N.W.

CHEMICAL INDUSTRIES.

A Monthly Review of the Progress of Technical Chemistry.

THE TREATMENT OF ADULTERATION IN BELGIUM.

By CECIL W. WOOD.

THE work of preventing the adulteration of foods and drugs in Belgium is based upon various laws and edicts issued from time to time from 1890 up to the present, though even as early as 1867 a law was issued making adulteration a punishable offence, but this did not contain any directions as to how such frauds were to be discovered and prevented.

Close examination of "Les Dispositions Légales et Réglementaires concernant les Denrées Alimentaires et l'expertise des Viandes" seems to denote that the position of an inspector under these Acts is in a different standard of responsibility to that which he occupies under the systems of other countries. Instead of being, as he often is, a mere agent for the collection of samples, and also technically unqualified, in Belgium the responsibility seems to rest upon him to a very large extent. In fact, the laws chiefly concern themselves with the work and duties of inspectors and analysts, whilst the more legal part of the system, dealing with the questions of conviction and defence, is not dealt with to any very great extent.

THE WORK OF INSPECTION OF MEAT AND MEAT PRODUCTS.

The working of the regulations, although left in the hands of the local authorities, is supervised by various Government officials. Thus the sale of meat and meat products is controlled by the Chief Veterinary Inspector, whilst the Chief Inspector of the Manufacture and Sale of Foods and Drugs is responsible for this particular branch, and the Inspector-General of Public Health and Hygiene has control of the more legal side of the Acts. The sanitary inspection of animals, especially with regard to cattle markets and slaughter houses, is carried out by sixteen officials under the control of the Inspector-General, who are attached to the administrative staff of the Board of Agriculture, and whose duties also includes supervision of the various officials controlling the sale of meat and food.

Before being eligible for registration as a qualified meat inspector or expert, it is necessary to possess a veterinary surgeon's diploma or, as an alternative, to furnish proof of a good elementary education and to pass a theoretical and practical examination in the following:—

(A) Knowledge of the laws and regulations as applied to the sale of meat.

(B) Description of animals.

(C) Recognition of the different organs and ability to describe their position in animals and carcasses.

(D) Knowledge of signs of health and sickness in animals both before and after slaughter.

(E) Knowledge of the nature of fresh meat, entrails, fat and blood and articles prepared from them.

(F) Capability of recognising such abnormal cases as necessitate immediate action.

No meat whatever can be offered for sale which has not been inspected, and officially stamped in the prescribed manner. For this purpose inspectors are granted the usual powers of entrance to shops, ports, stations; and they can also examine goods in transit from one place to another.

They can also take samples, but there is a curious regulation in this respect, that is, that the value of these in any one particular sampling must not exceed the cost of inspection expenses. A tax of 20 cents per 100 kilos. of meat or meat products is levied to cover a part of these experts' expenses on all such goods imported into Belgium.

If the result of examination be adverse, then the inspector must state whether the meat or meat product is totally unfit for human consumption or will be accepted after proper sterilisation, which must be carried out under official supervision. If his decision be not accepted, an appeal may be lodged within 24 hours. If there be no appeal, the meat or meat product is immediately destroyed. In the case of an appeal, the person interested must furnish a report from a veterinary surgeon for his defence. Should these reports not coincide, a Government veterinary expert is called upon to act as arbitrator, and his decision is legal and binding to both parties.

Should the arbitrator condemn the goods in question, the whole are impounded and the authorities informed as to what steps must be taken, and the seller is ordered to appear before a court of law. Meat totally unfit for human consumption must be either burnt or buried under police supervision. In the case of destruction of an animal the owner is given a certificate copied from the official register of destructions, containing a complete description of the animal and the reasons for destruction. If the inspector certifies that the goods will be passed as fit for consumption after proper sterilisation, they must be sent to the sterilising chambers in special conveyances together with a statement of their destination and place of sale, and also the quantity and nature of the meat. Beyond stating that the inspector must inform the local authorities, as to what offence and penalty has been incurred, no more information as to details of conviction and defence can be obtained from the publications already cited, which are stated officially to contain all the necessary information concerning Belgium.

THE WORK OF INSPECTION OF FOOD AND DRUGS.

The customary powers of inspection and sampling are granted to Government food and drug inspectors, whilst they can also place quantities of goods under temporary seizure without necessarily taking samples until the result of their own preliminary examination shows whether it is advisable to do so or not. These regulations do not make it imperative to send samples for official analysis, and the matter is left absolutely to the inspector's discretion. This procedure is very different from that of most countries, in England for example, where the action of taking any sample is automatically followed by an analysis, even where adulteration is admitted. Under the system in vogue in Belgium, if no sample be sent for analysis, the whole of the

samples taken are sent to the court for the magistrate's inspection. This procedure places greater responsibility upon the inspector, and allows him discretionary powers which he does not possess in other countries.

With the exception of goods seized on condemnation or conviction, all samples must be paid for at the time of collection, whilst, if there be any disagreement as to its value the sample may be left unpaid for together with a note to that effect, and the seller must send in his claim for payment to the local authorities.

Samples can also be taken from goods placed under the care of the Customs which have been declared for human consumption, but such samples can only be taken in the presence of Customs officers and an official note to that effect sent to those owning or about to receive the goods.

Samples taken for analysis are to be taken in duplicate wherever possible, and the regulations recommend the inspector to make a formal demand as to whether the seller would like to retain a portion of the sample, in which case the inspector shall, if possible, divide the sample into three parts, and any one may be chosen by the seller for his own use. If the inspector considers that analysis is advisable, then the original undivided sample or a portion of the divided sample is sent to an official analyst within two days, whilst a second portion of the divided sample is sent to the chief of the police in the district to be reserved for the trial.

If analysis fails to support conviction, then any goods which have been seized must be returned within a month, together with the value of the samples taken, and also a sum equivalent to any depreciation that the goods may have suffered during detention.

If, on the other hand, adulteration be proved by analysis, the inspector on receipt of the analyst's report, immediately seizes the goods from which the adulterated sample was taken. If the goods are liable to decompose or already decomposed, they must be destroyed under the supervision of the inspector, but if they can be rendered fit for human consumption the owner may be given the option of doing so.

ANALYSTS AND THEIR WORK.

Samples for official analysis are only sent to laboratories which are specially registered as having satisfied the following requirements :—

(1) They must not be connected in any manner with persons engaged in trade or in the sale of foods and drugs.

(2) They must be under the control of an analyst who can produce the following guarantees of competency : firstly, diplomas or certificates as proof of advanced chemical knowledge ; secondly, evidence of having had at least several years' experience in the practical analysis of foods and drugs.

(3) The laboratory must be equipped with such apparatus as is considered necessary by the Minister of Agriculture.

In Belgium there are altogether seven State laboratories, viz., at Anvers, Gand, Gembloux, Hasselt, Liege, Louvain, and Mons, whilst there are a number of provincial ones which are appointed for the analysis of samples. These other laboratories, belonging both to private analysts and to local authorities, are appointed by the same Minister, some for the analysis of foods alone, others only for drugs, whilst some are appointed for the analysis of all kinds of samples. The State Agricultural Laboratories have also been recently reorganised with the idea of their participation in the working of the Food and Drug Laws, whilst there are also the following specialised stations, viz., one for agricul-

tural chemistry and physics, a dairy chemistry station, an entomological station, and one for the study of plant diseases. This idea of separate stations for highly specialised purposes is shared with the French, who have also adopted the same plan.

These laboratories must always be open to inspection by officials specially appointed by the Government in the case of laboratories for food or general analyses, and the Medical Commission where drug analyses alone are undertaken.

The report given by an analyst should contain the following essential data :—

- (1) Date of analysis.
- (2) Date of receipt of sample.
- (3) Reference number of the sample, together with its description as given on the packet and a statement of the condition in which the packet was received.
- (4) Statement as to the condition of the sample itself and its weight.
- (5) A summary of the methods of analysis used on the sample.
- (6) The figures obtained by analysis and the conclusions drawn from them as to the genuineness of the sample or otherwise.
- (7) The cost of analysis.

The outer cover of the packet in which the sample was sent by the inspector must also accompany the analyst's report.

A copy of every report has to be sent to the Board of Agriculture, to whom analysts must also three times a year send a statement of their accounts, together with a list of the samples received and the analyses that it has been necessary to make on them for their reports. No mention is made as to the fees paid to analysts, which are decided by the Minister for Agriculture, but the regulations state that the Government analysts and those in charge of laboratories appointed under the Acts are at definite intervals to meet a committee of experts appointed by the Government for the decision of such questions as the unification of methods of analysis, the scale of fees, and the standards of purity.

	Total samples received.	Total samples analysed.
1903	26,354 ..	25,906 ..
1904	24,801 ..	24,497 ..
1905	34,430 ..	33,823 ..
1906	33,069 ..	32,623 ..
1907	28,851 ..	28,094 ..
1908	28,851 ..	28,571 ..
1909	32,117 ..	31,731 ..
1910	35,371 ..	34,998 ..
1911	28,729 ..	28,426 ..
1912	39,021 ..	38,843 ..

The samples for 1912 were roughly classed as follows :

Fertilisers	15,784
Cattle food	3,737
Beet sugars	20,095
Miscellaneous	598

Most offences against the Food and Drug Laws are dealt with by the law of 1890 which imposes a fine of 1 to 25 francs and imprisonment for one to seven days, these penalties being doubled for a second offence within two years. The following special fines are imposed : 50 to 200 francs for obstructing an inspector in the performance of his duties, which is increased to 500 francs with seven

days to two months' imprisonment on a second offence; for importing, manufacturing, or selling saccharine a fine of 1,000 to 5,000 francs can be imposed with imprisonment from four months to a year, whilst for similarly dealing with articles containing saccharine the fine is 200 to 1,000 francs with eight days to two months in prison; a person selling margarine or any such mixture as butter renders himself liable to a fine of 26 to 200 francs with eight days to two months' imprisonment, whilst for selling cattle-food which is adulterated or deficient in any of the essential constituents the fine ranges from 100 to 2,000 francs with twelve days to six months in prison, which on second offence is doubled, and the court may order the sentence to be printed in the newspapers and also posted on any shops or places used by the accused at his expense.

The above figures are taken from the annual report of the analysts of the different laboratories, but no indication of the extent of adulteration in any special class can be obtained.

It is interesting to note that all the returns as to the number of samples are given under two headings, viz., "Samples received" and "Samples analysed," and as there is a considerable difference in some cases it seems only feasible to presume that the analyst is not bound to analyse all the samples received.

The systems used in England and France have already been dealt with in this Journal, in January, 1914, and December, 1913, respectively.

OILS, FATS, AND MILK PRODUCTS.

By E. RICHARDS BOLTON and CECIL REVIS.

SEVERAL new oils have been described during the last few months, notably the oil of *Trichilia subcordata* by Östling (*Ber. deutsch. Pharm. Ges.*, 1913, 23, 667). The seeds come from German East Africa, and contain about 55% of fat, principally palmitin and stearin, but also contain a notable quantity of butyric acid, so that in consequence the fat shows an appreciable Reichert-Meissl value. The oil is stated to be suitable for soap and candle manufacture.

The *Bulletin* of the Imperial Institute (1913, 11, 559), contains an account of a number of little-known oil-seeds and the analytical figures for the oils obtained from them, and these should be carefully noted by those who have to examine specimens of new seeds or nuts.

Sprinkmeyer and Diedrichs (*Zeits. Unters. Nahr. Genussm.*, 1913, 26, 450) describe a variety of kapok oil coming from Mexico, the seed differing from true kapok seed and being probably identical with that of *Bombax malabaricum*. From the fibre of the kapok seed there is obtained on extraction with alcohol and benzene a substance closely resembling beeswax, and containing some 30% of unsaponifiable matter, chiefly melissyl alcohol (Streicher and Matthes, *Arch. Pharm.*, 1913, 251, 438). In the above-mentioned *Bulletin* of the Imperial Institute will be also found (p. 551) the results of a number of examinations of Para rubber seed oil and cake, discussed mainly from the point of view of comparison with linseed oil and cake, which it closely resembles. From their results it appears that Para rubber seed oil is less suitable for paint manufacture, but the cake gave quite satisfactory results as a cattle food. In view of the probability of a commercial output of this oil in the future, these results should be of interest.

A very interesting article on the preparation of palm oil

has been published by Kemner (*abs. J.S.C.I.*, 1914, 33, 146), dealing with some of the processes which have been introduced in order to supersede the crude native methods, and it appears that by a process used in Togo the free fatty acids have been kept below 8%, which is a considerable improvement on results usually obtained. In the immediately succeeding article by Hupfeld it is consequently suggested that a distinction may be drawn between ordinary palm oil and "edible" palm oil, the latter being taken as describing a product not containing more than 8% of free fatty acids, by which is obviously meant a product suitable for refining for edible purposes.

That the introduction of hydrogenisation has had an effect on the output of whale oil is seen from some facts published by Offerdahl-Larvik (*Ber. Deutsch. Pharm. Ges.*, 1913, 23, 558). It appears that the output for 1912 was over 200 million kilos, a very large portion of which is being hardened for soap and edible purposes, while the residual flesh and bones form an excellent substitute for guano. The author commits himself to the curious statement that the consumption of 0.5 gm. of nickel per day need not be considered harmful.

Meyer and Beer (*Monatsh. für Chem.*, 1913, 34, 1195) have examined arachis oil for stearic acid by Hehner and Mitchell's method, and find that the whole of the acids which separate consist of arachidic and lignoceric acid, no stearic acid being actually present.

The question of "wood oils" has been again taken up by Wilson in the *Bulletin* of the Imperial Institute (1913, 13, 441), who states that nine-tenths of the commercial wood oil is obtained from *Aleurites Fordii*, and that, strictly speaking, the Chinese variety is obtained from *A. montana* and the Japanese from *A. cordata*, and criticises Chapman's statement that his oil was obtained from *Paulownia imperialis*, being of opinion that the actual seeds were *A. cordata*.

For those interested in the synthesis of natural fats, attention may be drawn to a further paper by Kremann and Klein (*Monatsh.*, 1913, 34, 1291), which contains the results of a great number of experiments on the melting points of mixtures of the system tripalmitin-stearic acid-palmitic acid.

Several interesting analytical investigations have appeared lately, among which may be noticed one by Sutcliffe (*Analyst*, 1914, 39, 28), on the hexabromide test, in which the sources of error have been carefully gone into and a reliable method of procedure is described. The thermometer-bulb method for obtaining the melting points of fats is defended by Meldrum (*Chem. News*, 1913, 108, 223), and he points out that the method can be made reliable if only proper attention is paid to the necessary details.

The digitonin modification of the phytosteryl acetate test has received further notice by Fritzsche (*Zeits. Unters. Nahr. Genussm.*, 1913, 26, 644), who describes a fairly rapid method of carrying out this test, and who also draws attention to the fact that the digitonin method obviates the difficulties which arise when paraffin wax is present, whilst in a slightly earlier paper, Klostermann (*ibid.*, 437) maintains the necessity for complete saponification of the fat before applying the digitonin method, since, according to the author, esters of these alcohols may be present.

Arnold (*ibid.*, 654) draws attention to a method of detecting a yellow dye which is stated by him to have been used for some time for colouring fats. It does not appear, however, that the dye has been identified; but it is probably an easily reducible nitro dye.

The old question of the effect of the feeding with

coconut cake on the analytical figures of the butter-fat obtained from the milk of such animals has been again raised by Lederet (*Bull. Soc. Chem. Belg.*, 1913, 27, 325), whose results appear to show that the butter obtained shows distinct evidence of the presence of coconut oil. In this connection, Sundberg (*Zeits. Unters. Nahr. Genussm.*, 1913, 26, 422) has given a new formula for calculating the percentage of coconut oil present in butter from the figures obtained by Polenske's original method.

The Halphen test has suffered a further modification at the hands of Utz (*Chem. Rev. Fett. Ind.*, 1913, 20, 291), who proposes to substitute pentachlorethane for carbon bisulphide as the solvent for the sulphur. The results are stated to be more delicate and can be obtained with greater rapidity, and on the face of it there certainly appears to be some advantage in the modification.

A very useful dissertation on the non-nitrogenous extractive matters in feeding stuffs is given by König (*Zeits. Unters. Nahr. Genussm.*, 1913, 26, 273), who, after pointing out the confusion which arises from the different methods employed in attempting to differentiate between these substances, comes to the conclusion that an international standard method is highly desirable.

The question of the presence of cyanogenetic glucosides in linseed cake and the reasons for their non-poisonous effect have been very carefully set out by Auld (*J. Agric. Soc.*, 1913, 5, 409), who attributes the immunity of the animal very largely to the alkalinity of the saliva. The subject has also been investigated by Collins and Blair

(*Analyst*, 1914, 39, 70), who have given a method for easily estimating the quantity liberated under digestive conditions, and various opinions as to the reasons for poisoning are also discussed.

The bacterial and enzymic changes occurring in milk and cream at 0° C. have been investigated by Pennington and others (*J. Biol. Chem.*, 1913, 16, 331). They show that proteolysis, lactic acid formation and lipase action all occur at this temperature, but that the enzymes which are responsible are probably produced by the types of organisms which proliferate at this temperature.

An exceedingly interesting paper has been published by Laxa (*Milchw. Zentralblatt.*, 1913, 22, 663), on the lipoids and fat of "separator slime." He has succeeded in separating from such slime a fat or mixture of fats which certainly differs considerably from butter-fat, and which he considers is attached in some way to the cellular elements and possibly represents a transition stage in the production of butter-fat. The lipoids, which he has also isolated, are also regarded as having a similar function. The results are most interesting, but require confirmation, as there are considerable loopholes for error, of which, however, the author appears to be fully aware.

A new method for ascertaining the likelihood of "lochbildung" in cheese is described by Steinegger (*ibid.*, 1914, 23, 57), who uses a new reagent for this purpose called "Casolin," which appears to be an acid preparation of rennet, and the results, according to the author, are satisfactory.

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

CHAPTER IV.

At the present time the outstanding problem of chemical industry is concerned with the large-scale fixation of atmospheric nitrogen. It is only a few years ago that attention was drawn by several chemists of eminence to the possibility of the exhaustion of Chili nitrate, our largest natural store of combined nitrogen, at a not far-distant date; and their warning has proved effective, for since that time, attempts to replace the natural material by artificial products have been very numerous. The few that have materialised industrially involve four distinct methods:—

- (1) The direct oxidation of air by means of the electric arc to form nitrous oxides, which are subsequently converted into nitrates; as in the processes of Birkeland and Eyde, Schönherr and Pauling.
- (2) The high-temperature fixation of nitrogen to metals and metalloids, followed, if necessary, by decomposition of the resulting compounds; as in Serpek's process, the Frank and Caro process, and the several processes of the Badische Anilin u. Soda Fabrik.
- (3) The synthesis of ammonia, which forms the basis of Haber's process; and
- (4) The oxidation to nitric acid of ammonia,

obtained preferably by the decomposition of the compounds produced by method (2), by a process associated with the name of Ostwald.

Of the above, the processes which depend primarily upon catalytic phenomena are those of Haber and Ostwald, and these two will, therefore, be discussed, together with Serpek's process, which has some interest catalytically.

I. HABER'S PROCESS.

The affinity of nitrogen for hydrogen, even at high temperatures or under the influence of spark or silent discharge, is so slight as to be almost negligible. Under the influence of a catalyst, too, the smallness of the yield was formerly considered to hold out no prospect of commercial advantage. This was shown in 1881 by Johnson, who used platinised asbestos and obtained only traces of ammonia, a result which even then was not borne out by later experiments. Perman, twenty years after, could detect only minute quantities of ammonia after passing a mixture of nitrogen and hydrogen over red-hot iron and other bodies.

In 1904 Haber undertook the investigation of the ammonia equilibrium, using modern physico-chemical methods. Nernst, in 1907, communicated

the results of experiments on similar lines. Both agreed that at $1,000^{\circ}\text{C}$. the decomposition of ammonia into its elements is almost quantitative; which is to say that, under the same conditions, merely traces of ammonia would be formed. At lower temperatures than $1,000^{\circ}\text{C}$., the activity of the catalysts employed sank so low as to render them unworkable.

Undismayed by these unpromising results, Haber conducted further experiments, with the assistance of the Badische Anilin u. Soda Fabrik, in which was utilised the thermodynamical fact that pressure shifts the equilibrium of such a mixture of two reacting gases in the direction of further combination. From the results of the experiments he was able to show, in 1908, that the production of ammonia is possible on a practical scale if the mixture of nitrogen and hydrogen be kept under a constant high pressure during the whole of an operation in which the gases are alternately subjected to the catalytic activity of various materials, and then freed from ammonia by absorption or condensation at a lower temperature.

The establishment of Haber's development upon an industrial scale was at once taken up by the Badische firm.

The novel difficulties arising from the employment of high pressures at temperatures approaching red heat, and attendant upon the use of a combustible, and at the temperatures involved, even a corrosive gaseous mixture, were successfully overcome by the aid of a special construction of apparatus, which cannot be detailed here, and the large-scale production of ammonia was immediately begun (1913).

A diagrammatic sketch of the plant is shown in Fig. 4. The mixture of gases, in the theoretical proportions of three volumes of hydrogen to one of nitrogen, and under a compression of about 150 atmospheres, is passed through a heat-interchanger E, consisting of a double coil, to the annular space between two tubes A, B, the first of which contains the catalytic material, whilst the second is surrounded by an electric coil. As both tubes are embedded in insulating packing in an outer tube F, the temperature can be maintained at any point between 500° and 700°C . After passing through the catalysing material and the inner tube of the heat-interchanger, the gases reach a condenser C,

where the liquid ammonia collects in a vessel V. The uncondensed gases are forced again through the circuit by means of a pump P, fresh nitrogen and hydrogen being introduced by the valved pipe D. The heat-interchanger is designed to transfer the heat evolved in the catalyser by the reaction to the cooled ingoing gases.

The very high pressures involved naturally limit the space that may be filled with contact material. However, at 200 atmospheres and a temperature of $650\text{--}700^{\circ}\text{C}$., a yield of 250 gms. of ammonia per litre of contact space per hour is readily obtained, using pure iron as the catalyst, and passing the gases through at a speed of 250 litres per hour.

Returning now from this brief glance at the finished process, consideration must be given to the large amount of pioneer work which enabled Haber to define *a priori* all the conditions of the problem.

In the following table are embodied some of his results relating to the influence of pressure upon the ammonia equilibrium at various temperatures. It will be observed, on inspection, that an approximate proportionality exists between the working pressure and the relative percentage of ammonia in equilibrium.

Furthermore, from the fact that the yield

increases as the temperature falls, the conclusion might be drawn that the lower the temperature, the more practicable the process. But there must also be taken into account the rapid decrease in the reaction velocity with the temperature, and since

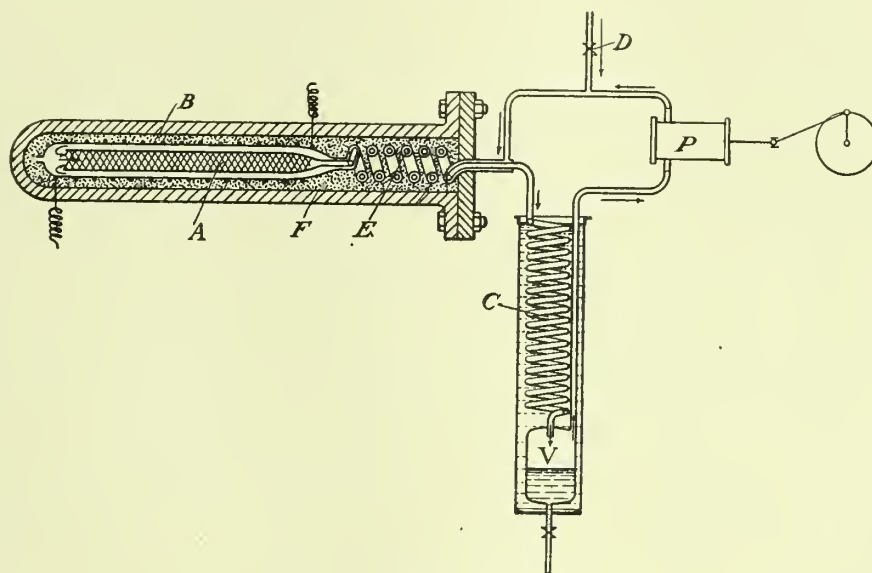


FIG. 4.—HABER'S APPARATUS.

Pressure (in atmospheres).	Temperature $^{\circ}\text{C}$.				
	550	650	750	850	950
1	0.077	0.032	0.016	0.009	0.005
100	6.7	3.02	1.54	0.874	0.542
200	11.9	5.71	2.99	1.68	1.07

20.
10.
40.
5.
75.

at values much below 500°C ., the reaction velocity becomes impracticably small, a lower limit to the temperature is arbitrarily fixed thereby.

Another factor which goes still further towards defining the minimum temperature is inherent in the catalysts themselves. The catalysts first worked

with, such as iron, manganese, chromium and nickel, required comparatively high temperatures for the development of their activity; but as the number of catalysts increased, others became available, such as osmium and uranium, which display great activity within a temperature range of 500—700° C. These temperatures now furnish the limits for practical working.

Under no circumstances, it will be noticed, are the yields so high as to render it remunerative to allow the residual gases to escape into the atmosphere after the reaction products have been removed, and it is for this reason that a continuous process has been adopted.

With regard to the rate of flow of the gases, experiments have shown that while the ammonia concentration decreases as the rate of flow increases, other conditions being unaltered, the product of the concentration and the rate of flow, which is a measure of the amount of ammonia produced in unit time, actually rises and to no inconsiderable extent. A premium is thus placed upon a rapid circulation.

Recognising the importance that is attached to the catalytic function, the Badische firm has made a very minute investigation into the relative efficiencies of various materials and the effect of extraneous bodies upon their activity. The results in these directions are of first-rate importance.

The most favourable catalysts appear to be metallic osmium and uranium carbide. The former is ruled out of consideration for industrial application by reason of its rarity and costliness, whilst the second suffers from the disability that water must be most rigorously excluded from the reacting gases. Now, as we shall see in a later chapter, gaseous combination is dependent upon the presence of a trace of moisture. The dessication of the gases must not therefore be carried as far as is desirable for the well-being of the catalyst, with the result that the irreducible oxide is formed and the material suffers continual depreciation.

Judging by the most recent patents, pure iron is the catalyst generally employed in this process. Using this material and with the aid of various minor improvements, it has now been found possible to lower the working pressure to the neighbourhood of 50 atmospheres. In all cases it is essential, in the interests of efficiency, that the catalyst be prepared at a temperature not greatly exceeding 600° C.

Of the remaining substances which catalyse the reaction, and they are many, the most interesting are molybdenum and molybdates, tungsten and its alloys, and cerium with its congeners. Platinum, on the other hand, though related to osmium, possesses but a slight catalytic activity.

The most important feature attached to the investigation of the Badische firm was the discovery that the activity of the catalysts can be increased by the addition of certain foreign bodies. These "promoters," as they have been called in Chapter I., include various metals, the oxides, hydroxides and salts of the alkali and alkaline earth metals, as well as many other substances of the most varied nature. In many cases just a trace of the con-

taminating body considerably enhances the activity of the catalyst. Moreover, all the catalysts appear to possess the capacity for invigoration.

The manner in which the foreign material increases the catalytic activity is not easily explained. Most of the catalysts appear to function by participating in the reaction, *i.e.*, by the formation of readily reducible nitrides, and the promoters may then either confer a kind of skeleton formation upon the catalyst, thereby maintaining a large surface area, or in some as yet unknown way may diminish the chemical resistance of the reaction taking place on the surface of the catalyst.

Of course, contamination with certain substances has to be carefully avoided. As in the case of the contact reactions previously considered, there exist bodies which, even when present in the smallest traces, act as poisons to the catalyst. In the present instance, the great trouble occasioned by them necessitated a minute study of the influence of all possible impurities. Examples of bodies acting deleteriously are to be found in sulphur, selenium, tellurium, phosphorus, arsenic, boron and their compounds; as also many carbon compounds; and certain metals of low melting-point, which can be readily obtained by reduction from their compounds, but are not themselves catalysts. Lead, zinc, bismuth and tin are to be avoided, too. Such minute quantities of any of the above-mentioned as are to be found almost always in the purest commercial products and so-called pure gases are sufficient to diminish very seriously the catalytic activity. In Chapter I., for instance, it is mentioned that an impurity of 1.05% sulphur in iron renders it nearly useless.

In view of these facts, every care is taken both to obtain pure contact material and to free the reacting gases from all poisonous bodies. The first is a comparatively easy matter, the ordinary methods of purification of course being employed. But the continuous removal of contact poisons from the reacting gases is a more difficult undertaking, particularly as chemical contingencies have brought about the replacement of the electrolytic hydrogen formerly employed by the impure hydrogen obtained from coal. This latter method of production depends upon the separation by liquefaction of the constituents of water-gas, hydrogen and carbon monoxide. Traces of carbon monoxide have then to be eliminated, together with the gaseous impurities derived from the coal decomposition, as well as the contaminations arising from the use of piping, lubricating oil in the pumps, etc. A development of this process of hydrogen production has recently been patented, in which carbon monoxide and steam are caused to interact under pressure at 300—600° C., in the presence of a catalyst such as iron, nickel and the like, thereby producing carbon dioxide and hydrogen, of which the former is removed by absorption, leaving hydrogen ready compressed for the ammonia synthesis. The nitrogen employed is usually obtained by the fractionation of liquid air.

—In general, the gases are filtered, washed, and

then conducted over various solid absorption agents, whilst in some cases further purification is effected by passage over a portion of the same material as is employed as catalyst, at a raised temperature, before introduction into the catalyser. This material is renewed repeatedly. The yield is found to be increased if both gases are deprived of water and of substances capable of producing water.

Recently the original process has been modified by passing nitrogen and hydrogen *alternately* instead of *simultaneously* over the contact substance. Under these circumstances extremely good yields result if the nitrogen be mixed previously with a small proportion (1—3%) of hydrogen. The same happens in the ordinary process if the compressed gases be allowed to expand after leaving the catalyser.

(To be continued.)

INSTITUTE OF CHEMISTRY.

THE thirty-sixth Annual General Meeting of the Institute of Chemistry was held at 30, Bloomsbury Square, on Monday, March 2nd, Professor Raphael Meldola, President, in the Chair.

The Report of the Council having been received and adopted, the meeting proceeded to elect Censors and Auditors.

The President, in the course of his address to the Fellows and Associates, referred to the progress of the fund for the new buildings of the Institute and acknowledged the generous support of many companies, firms and individuals, other than members, who had contributed. Taking into account the promise of an anonymous benefactor to double every subscription received beyond £12,000 up to the amount of £2,000, it was probable that less than £1,000 was now required; but if more were received the Buildings Committee could easily invest it in improved and more serviceable finishings. The building had progressed most favourably until the trades dispute, and, as there were signs of approaching settlement, it was hoped that the work would be completed before the autumn.

Referring to the endeavours of the Institute to secure fuller recognition for the profession of chemistry, the President recalled the evidence given by Sir William Tilden and Sir William Ramsay, as representatives of the Institute, before the Royal Commission on the Civil Service. The main portion of their evidence related to the conditions of service of chemists engaged in the Department of the Chief Inspector at Woolwich Arsenal. The Council of the Institute, in the memorandum submitted to the Royal Commission, stated that the chemical staff in that department should be controlled by a chemist of the highest efficiency. The rapid development of science in every direction was leading to increased specialisation. The real expert whose knowledge and experience were of most value to the community was the highly-trained man who had specialised in some particular field. Surely such a man was the most competent to control the work of any public department which was concerned with his own subject. The training and experience which had raised him to his position of efficiency were no less protracted and severe than those required for the attainment of similar status in any other profession. Why therefore should there be this tendency to subordinate expert scientific service to non-expert control? The question of national defence was an important one, and the valuation and control of materials required in our arsenals and the study and application of

new discoveries having any bearing upon "the arts of war" were no less matters for chemical control than the conduct of an army in the field would be a matter for control by the General Staff. Yet while the medical service took army "rank," the chemist, whose services were of equal importance, not only took no "rank" at all, but was made responsible to superiors having no special knowledge of his subject. This state of affairs, rendering as it did the public service of chemists an unattractive career to the best talent in the profession, was fraught with danger to the future well-being of the country and was a short-sighted policy which, in time of trouble, might well lead to disaster. It was a matter which could not be lightly dismissed, because it affected only a small number of chemists—it was a question of principle, of far-reaching consequences, and it was to be hoped that the Royal Commission would give heed to the representations of the Institute.

Another move in this same direction was the rearrangement of the chemical staff of the London County Council, which had been carried out since the retirement of Dr. Clowes. Under the new scheme, the Chemical Department—as an independent department—ceased to exist, and the chemical staff was subordinated to the Medical Officer of Health. This again appeared to be a distinctly retrograde step and one which the Institute could not but deplore. The matter had been represented to the Chairman of the County Council, Mr. Cyril Cobb, and he had made it perfectly clear that in this rearrangement there had been no intentional slur cast upon the status of the chemical staff.

In other branches of the profession, particularly in its applications to industry, the prospect for young chemists was improving. Not only was there little difficulty in placing Associates in appointments, but they were offered higher commencing salaries than formerly, and, although the cost of living had greatly increased, they were generally able to secure a "living wage" in most branches of the profession at the outset of their careers, which was much less frequently the case a few years ago.

Professor Meldola then dealt at considerable length with the Report of the Conference of Professors of Chemistry, held under the auspices of the Institute in October last, which was attended by professors from practically all the principal educational centres of the country, the Institute thus providing an arena for the free discussion of the broad question of the education of professional chemists. The report of this important meeting was under the consideration of a special committee composed of representatives of every department of the profession—professors, and teachers private consultants, practitioners and those who are accustomed to the scientific control of industries. Their task would be one of no little magnitude and would probably effect considerable recasting of the Regulations of the Institute in the light of modern educational development. Whatever scheme might eventually be adopted it was certain that the Council would safeguard the status of the existing members. Professors and teachers would gladly welcome the support which the Institute might lend to their endeavours to raise the educational level to the required standard, while senates, councils, and governing bodies could not afford, on public grounds, to set aside curricula of studies, or to ignore a standard, regarded as essential for efficient training for the chemical profession by a body fully representative of that profession. It was in this way that the influence of the Institute in the educational world might, through a revision of the existing Regulations, be exalted into a still greater power, making for the highest efficiency of the chemist of the future.

SURFACE TENSION AND SURFACE ENERGY AND THEIR INFLUENCE ON CHEMICAL PHENOMENA.

By R. S. WILLOWS, M.A., D.Sc., and E. HATSCHEK.

CHAPTER I.

AMONG the purely physical properties of their materials, to which the chemist and the biologist have been compelled to pay an increasing amount of attention during recent years, surface tension undoubtedly occupies the first place. In a great measure this is due to the development of colloidal chemistry, which deals with matter in a state of extreme sub-division, and therefore with a great development of surface for a given mass, so that the properties of surfaces become important, and sometimes decisive, factors in the behaviour of such systems.

Everybody is familiar with a number of phenomena which indicate that the surface of a liquid is in a condition of tension, or—to use a parallel which is graphic, while incorrect in one particular—behaves as if it were composed of an elastic membrane. If a camel-hair brush is submerged in water, the hairs remain separate as they do in air, but they collapse on being withdrawn, *i.e.*, the surface of the adhering water behaves like an elastic sheath, tending to contract. Drops of liquid not exposed to external forces, that is, either falling freely or suspended in another liquid of the same density, assume a spherical shape, the sphere being the body with the minimum surface for a given volume.

While these phenomena demonstrate beyond doubt the existence of a surface tension at the surface of a liquid bounded by air or, strictly speaking, its own vapour, we can obtain a much clearer view of its action by considering an arrangement first suggested by Maxwell. Imagine a rectangular wire frame AB (Fig. 1) on which a movable wire CD slides parallel with AB . If we fill the rectangle $ABCD$ with a film of liquid, this will contract and raise the wire CD . If we now weight the latter, we can just find a weight which will stretch the liquid film—within certain limits—

indefinitely. Bearing in mind that the film as here described has two surfaces, we find that this weight gives us the double surface tension exerted by the width CD , and if we divide half the weight by this width, we obtain the *surface tension per unit length*, which is the form in which this constant is usually given. The units employed are either milligrammes per millimetre, or more generally, absolute units,

viz., dynes per centimetre. (The dyne is the force which imparts an acceleration of one centimetre per second to the mass of a gramme; it is accordingly gm./980 , or approximately equal to a milligramme weight.) It is easy to see that values given in mgm./mm. are transformed into dyne/cm. measure through multiplication by the factor 9.8.

The possibility of stretching the film indefinitely shows the important fact that the *surface tension per unit length is independent of the size of the surface*, and this constitutes the difference between the surface tension and the tension of an elastic film. If we imagine, instead of the liquid film one of indiarubber, it is obvious that a given weight can only stretch this to a definite extent. To enlarge

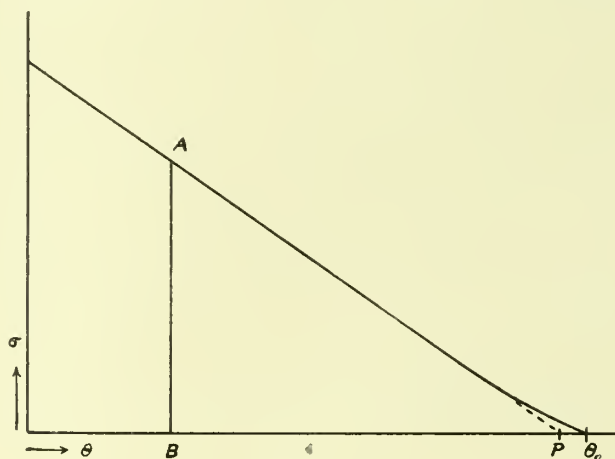


FIG. 2.

the film further additional weight would be required or, in other words, the stress per unit length is not independent of the size of the surface, but increases with the extension of the latter.

We now return to a consideration of what occurs when we stretch the liquid film in the arrangement referred to above. For the sake of simplicity, we assume the width CD to be unit length, and we shift the wire CD , with the weight equal to surface tension per unit length, again through unit length. Remembering that the work done is measured by (applied force $\times$ distance through which it moves the body acted upon) we see that the work done is equal to (surface tension $\times$ unity) and this goes to increase the energy of the surface. Thus, *the work done when the surface is increased by unity is numerically equal to the surface tension*, the temperature being constant. Consistent units must of course be used; if the surface tension is given in dyne/cm. , the work is given in ergs. (An erg is the work done when one dyne moves the point to which it is applied through a distance of 1 cm.)

The following values of the surface tension of various liquids (all in dyne/cm.) will help to give some idea of the order of forces we are dealing with : water at 18° , 73 ; mercury at 15° , 436 ; ethyl alcohol at 20° , 22, etc. We shall in the following use the symbol σ to designate surface tensions generally.

The mention of the temperatures in connection with the figures given above suggests that the value of surface tension varies with the temperature, and this is indeed the case. If we call

θ the temperature

σ_{θ} the surface tension at that temperature

σ_0 the surface tension at 0°

σ_{θ} is given by the following equation :—

$$\sigma_{\theta} = \sigma_0 (1 - a\theta),$$

in which a is a constant, *i.e.*, the surface tension decreases as the temperature rises ; it becomes zero at the critical temperature of the liquid. The equation, which holds good for temperatures more than about 40° below the critical temperature, is that of a straight line. If we plot θ as abscissæ and σ as ordinates, the straight line intersects the θ axis at a point P about 6° below θ_c . (Fig. 2). The surface tension AB at any temperature θ is then proportional to PB, or $\sigma_{\theta} = b \cdot BP$, where b is a constant depending on the nature of the liquid. If the temperature corresponding to the ordinate AB is O, we have

$$B\theta_c = \theta_c - \theta \text{ and } PB = \theta_c - \theta - 6,$$

and obtain the following general expression for the surface tension at any temperature

$$\sigma_{\theta} = 6(\theta_c - \theta - 6).$$

This knowledge of the law connecting surface tension and temperature enables us at once to decide a highly important question, *viz.*, whether the production of surface energy is accompanied by the temperature changes, in other words, by the liberation or absorption of heat. We can solve this question by applying the principle of Le Chatelier, which says that, when the state of a system is changed, the system alters, so as to oppose a greater resistance to that change. A few instances will make the principle and its application clear. If air is compressed, it becomes hotter, and thereby tends to expand, *i.e.*, to resist the compression. If current is passed across a junction of two metals, a back electromotive force is set up, tending to produce a current flowing in the opposite direction. Dissolving a salt in water causes cooling, this being a change which opposes a greater resistance to further solution, as the solubility decreases with falling temperature. By similar reasoning, we find at once that a liquid film is cooled, when suddenly stretched, because its surface tension is thereby increased, and it opposes a greater resistance to further extension. Hence it follows that, if a surface is increased isothermally (*i.e.*, without a change in temperature), heat must flow into the surface film to keep its temperature constant. The amount of heat required to do this was first calculated by Lord Kelvin.

We now consider once more, in the light of the

foregoing, the enlarging of the surface in the arrangement shown in Fig. 1. If CD is pulled outwards a distance x , the work done is

$$w = \sigma \cdot AB \cdot x$$

or, if we call $AB \cdot x$, the increment in surface, ds , the work is

$$w = \sigma \cdot ds$$

σ , as already explained, is numerically equal to w (consistent units being assumed), the amount of work required to produce an increase in surface of 1 sq. cm., the temperature remaining constant. This work, of course, goes to increase the surface energy, but *it is not correct to define the surface tension as surface energy/cm²*, since there is in addition an inflow of heat, which also increases the energy. Thus, with water at 0° , σ is 75 dyne/cm., and the work required to produce 1 sq. cm. of surface is 75 ergs ; in addition to this there is an inflow of heat which, reduced to units of work, amounts to about 40 ergs.

The *total energy* of the surface, therefore, consists of two terms, of which one represents the amount of work done against surface tension, and the other the inflow of heat during the extension of the surface. If we call this total energy λ , the following equation, given by Helmholtz, expresses the connection between surface tension and total energy at any temperature :—

$$\sigma = \lambda + \theta \frac{d\sigma}{d\theta}$$

$\frac{d\sigma}{d\theta}$ is the differential coefficient of the function which expresses the variation of surface tension with temperature. We know already that this is a linear function over a considerable range, and that surface tension decreases with increasing temperature, so that the differential coefficient becomes a constant and negative, *viz.*, $\frac{d\sigma}{d\theta} = -c$. Over the same range λ , the total energy, is a constant.

We are naturally interested in connecting a physical constant, like surface tension, with other physical constants, and one such connection is immediately suggested by the decrease in surface tension caused by an increase in temperature. It is only natural to inquire whether there is any parallelism between this and the most obvious change produced in a liquid by increasing temperature : expansion. Measurements have shown that this is indeed the case, and that there is marked parallelism between the temperature coefficient of surface tension, *i.e.*, the decrease caused by a rise in temperature of one degree represented by the constant a in our first equation, and the coefficient of expansion.

The greater the latter, the greater also is the decrease in surface tension per degree, and the ratio temperature coefficient/coefficient of expansion is approximately the same—between 2 and 3—for a very large number of liquids. Some explanation of this fact, as well as many other connections between surface tension and various physical constants will be suggested by theoretical considerations, to which we now proceed.

CHAPTER II.

THE theory of surface tension, in other words, the problem how certain known facts and certain assumptions about the liquid state can be made to account for the existence of a surface tension, has been treated exhaustively by Laplace, by Gauss, and more recently by Van der Waals. The mathematical apparatus employed is very considerable, and we must confine ourselves to a statement of the assumptions on which the simplest of the theories, that of Laplace, is based.

Laplace assumes that the molecules of a liquid attract one another with forces acting over very small distances only. The distance beyond which this attraction becomes imperceptible is known as the radius of molecular action, and various considerations, into which we cannot go, lead to a value of about 5×10^{-7} cm., or $5 \mu\mu$ for this radius. It is obvious that forces of this kind, which are inappreciable at distances of, say, 1 mm., may yet be enormous in the small space in which they are operative. Such a conception is naturally somewhat difficult, but becomes easier if we consider a parallel case, that of adhesion between surfaces in contact. This is also caused by attraction, effective only over such short distances that the slight irregularities of even smooth surfaces prevent it from acting. Yet copper, for instance, can be polished to such a degree that a cube of the metal will support eleven others merely by adhesion. This means that 1 sq. cm. of surface carries a copper prism 1 cm. square and 11 cm. long, which accordingly weighs 98 gms. Yet a slightly insufficient polish or the presence of some particles of polishing material renders this attractive force inoperative.

Granting Laplace's fundamental assumption, we see that the molecules in the interior of a liquid are subject to attraction in all directions, but that a different condition prevails in a layer at the surface, the thickness of which is smaller than the radius of molecular action. In this layer the molecules are subject to unbalanced attraction from the adjoining molecules in the interior, in other words, to an inward pull, which keeps the surface in a state of tension. If we imagine a small prominence raised somewhere in the surface, the tendency of this onward pull would be to bring it into the general level of the surface, and the effect is the same as that of an elastic membrane covering the surface, to return to the simile employed at the beginning.

A further conclusion, however, remains to be drawn which is less familiar. The effect of the mutual attraction between molecules must be the same as that of a pressure existing in the liquid, and this is called the *intrinsic pressure*. A liquid must, therefore, oppose a resistance to forces tending to enlarge its volume or, in other words, must possess cohesion or tensile strength. We habitually overlook this fact, only because we handle liquids almost exclusively under conditions which change their shape, but do not alter their volume. If, however, we attempt to do the latter, the existence of cohesion or intrinsic pressure is easily demonstrated, and

some experiments in this sense will be referred to below.

It is fairly clear that the foregoing reasoning applies, not only to liquids, but also to solids or even gases, both of which ought accordingly to possess surface tension and intrinsic pressure. As regards solids, we find support for this proposition in the continuity of phenomena, which is the basis of physical science. We know that the surface tension of a liquid increases with falling temperature, and it is therefore inconceivable that it should suddenly disappear when the temperature falls to the freezing point and the liquid changes into solid. With gases, the case is not quite so clear, but we can say at once that, in view of the smallness of the radius of molecular action, the attraction between gas molecules must be very slight, owing to the distance between them. Thus, 1 cc. of water becomes nearly 1,700 cc. of steam at 100° , and the distance of the molecules in the latter must therefore be $\sqrt{1,700}$, or about twelve times greater than that between the molecules in water.

(To be continued.)

PERSONAL AND OTHER NOTES.

DR. T. M. LOWRY is among the fifteen recently selected candidates for admission to the Royal Society.

MR. J. Dewrance has given the sum of £2,000 to the Royal Society, the interest on which is to be utilised for the promotion of experimental research.

An important discussion took place before the Royal Society on March 19th on the subject of the "Constitution of the Atom." Messrs. Rutherford Soddy, and others took part.

The Government chemist, in his annual report, announces a considerable increase in the number of samples tested, which reached 209,502 as against 195,170 for the previous year; 224 samples of home-grown tobacco were tested.

We deeply regret to announce the death of Professor Kennedy Duncan, who was so well known in connection with his scheme of industrial research scholarships. The progress of developments in this direction were recorded in this Journal from time to time, particulars coming direct from the founder himself. His charming personality made him many friends on this side of the water, when he attended the International Congress of Chemistry in London.

The Dyers' Company medal awarded by the Society of Dyers and Colourists has been awarded for the year to Mr. W. Harrison.

NEW PUBLICATIONS.

MESSRS. J. & A. Churchill announce the two following new works:—

"Molecular Physics," by J. A. Crowther, M.A., Demonstrator in Physics, Cavendish Laboratory, Cambridge. With 29 illustrations.

"The Synthetic Use of the Metals in Organic Chemistry," by A. J. Hale, B.Sc., Demonstrator, City and Guilds of London Institute; Technical College, Finsbury.

CHEMICAL ENGINEERING.

CONSTRUCTION OF FURNACES FOR MANUFACTURE OF CHEMICALS.¹

By A. COCHET.

CALCULATION of the resistance of materials applied to current types of structures gives a guarantee of safety, when judiciously made, from the point of view of solidity of these structures. This is made possible by the knowledge we possess of the way in which materials work (flexion, compression, shearing, etc.), the extent of the strains produced, and the portions of the works in which they appear.

The conditions of temperature to which materials are subjected in furnaces considerably alter their resistance.

If to this we add the fact that it is not actually possible to estimate the strains produced in masses of masonry brought to a high temperature, owing to the variations of volume they undergo, one will understand that the building of furnaces is more a matter of experience than of calculation. Consequently there is a risk of accidents, in new types of furnaces the first time they are fired, involving repairs in certain weak spots.

The number of types of furnaces is small, but that of their variants very great. If a substance has to be heated without stirring during its calcination, a furnace of the shaft type will be selected (lime-kiln, blast furnace, foundry cupola, and in general, all *reduction furnaces*).

If, on the contrary, the material has to be mechanically worked during calcination, it will be heated on a hearth within reach of the implements (type, regenerative furnaces, muffle furnaces, etc., and, in general, all *oxidising furnaces*).

We cannot here enter into details relating to each of these furnaces. Arrangements such as the form of the hearth, movement of the flames or hot gases, formation of the arches, flues, and regenerators, when required, depend, in each case, upon a number of circumstances.

We shall merely note the general rules to be followed to assure stability of furnaces as constructions in all cases.

The three essential parts of a furnace are :

(1) Internal lining with refractory materials to receive the substances to be heated and which is heated to a high temperature. For economic reasons this part is made as light as possible.

(2) An outer facing with red bricks, to ensure stability of the structure, completely surrounding the refractory part, and thus acting as insulator.

(3) A metal armature to consolidate and prevent dislocation of the masonry, owing to unequal expansion.

Preservation and stability of furnaces depend upon selection of refractory materials, careful construction, and the armature.

We shall here limit ourselves to study of these influences.

I. REFRACTORY MATERIALS.

The essential qualities required in these materials are as follows :—

(1) Infusibility at the working temperature of the furnace.

(2) Slightest possible variation in volume under the influence of temperature.

(3) Resist the action of the products heated.

(4) As little porous as possible.

(5) Have a sufficient mechanical resistance to withstand the effects, in some cases, of impact with the tools.

Fusibility.—There are great differences in refractory materials as regards fusibility, and the chief constituents met with are given in the following table, together with the type of material in which they are found.

This table demonstrates that the most refractory product is carbon, employment of which is not common owing to its easy combustion. In fact, such a refractory product is never required in industry, and has rarely been adopted except for laboratory graphite crucibles.

Magnesia, which ranks second, is not utilised owing to its expensiveness, and then its irregularities in expansion. Dolomite bricks are extensively used for construction of open hearth furnaces, converters and electric furnaces.

Aluminous bricks with base of bauxite are certainly more refractory than siliceous, and are particularly suitable for metallurgy when they are brought into contact with calcareous products, but their cost price is also much greater.

Employment of silica bricks (98 to 99% SiO_2) is growing very much. They are very refractory, and also have the advantage of giving, with lime, binary compounds less fusible than the ternary ones $\text{SiO}_2\text{Al}_2\text{O}_3$, $\text{Ca} \cdot \text{O}$, and this is an advantage in metallurgy.

Fireclay bricks are the ones most in use, as they are cheap.

In the chemical products' industry, and especially for construction of sulphate furnaces, clay bricks are utilised for all parts in contact with hydrochloric acid. Percentage of SiO_2 in these bricks is increased by adding quartz, so as to obtain :—

SiO_2	..	..	..	..	..	70
Al_2O_3	..	..	..	..	..	25
Various	..	..	..	..	..	5
						100

Fusibility is tested by heating fragments with sharp edges in a crucible, together with Seger cones.

Fusion is very plain on these edges.

Variations in volume of refractory materials, under the action of heat may be due to expansion, shrinkage from dessication, variation of density caused by allotropic transformation.

It is astonishing how little information is given in technical literature relating to the coefficients of expansion, and, in general, the properties of refractory materials. Young chemists preparing for their degree would do well to treat important questions like this, rather than so many others of much less immediate practical interest.

The only figures I can find are taken from the treatise

¹ Translated from *Revue de Chimie Appliquée*, December, 1913.

on heating by Mr. H. Le Chatelier ("Introduction to the Study of Metallurgy"). They regard clay bricks, which expand 0.5% between 0° to 500° C. and 0.7% from 0° to 1,000° C.

Addition of sand raises the coefficient of expansion. The mixture

Clay	30%
SiO ₂	65%
CaCO ₃	5%

expands 0.7% from 0° to 500° C., and 1.3% from 0° to 1,000° C.

In building furnaces it is very important to make an allowance for expansion. Thus the extremities of the

SiO ₂	75
Al ₂ O ₃	20
Various	5
	100

These bricks had been employed to build a very sur-based arch (span 2.50 metres; pitch 0.25 metre).

Imperfect burning and consequent shrinkage had resulted in fall of the arch.

Dimensions of the bricks before burning were 222 × 111 × 75 and after burning at 1,500° C., 218 × 100 × 74. The respective shrinkage on the length, width, height, was 1.8, 1.8, and 1.33%.

Nature of the Refractory Materials.	Constituents.	Fusion Point.	Materials in which the Constituents are found.
Carbon	—	3,000°	Coke bricks. Graphite crucibles.
Magnesian	Mg . O	2,200°	Magnesia bricks.
Calcareous	Ferruginous magnesia	1,500°	
Calcareous and magnesian	Ca . O	1,950°	Calced dolomite. Open hearth.
Siliceous	Ca . O + Mg . O	2,000°	Bricks 99% Si . O ₂
	Si . O ₂	1,800°	
Siliceous and calcareous	Si . O ₂ . Ca . O	1,510°	(Eutectic SiO ₂ + Ca . O).
	1.25Si . O ₂ ; Ca . O	1,450°	Cement bricks.
	Si . O ₂ . 3Ca . O	2,000°	Bauxite bricks.
Aluminous	Al ₂ O ₃	2,050°	
Aluminous and calcareous	Al ₂ O ₃ 3Ca . O	About 1,500°	
	Al ₂ O ₃ 3Ca . O		
	2Si . O ₂ Al ₂ O ₃	1,830°	Calcined clay.
Siliceous and aluminous	10Si . O ₂ Al ₂ O ₃	1,690°	Quartzose clay.
	Micaceous clay	1,200°	
Siliceous, aluminous and calcareous	2SiO ₂ , Al ₂ O ₃ , CaO	About 1,400°	Lime joints, slags.
	2SiO ₂ , Al ₂ . O ₃ . 3Ca . O		

arches should never be buttressed, and there should be an expansion joint of 0.5 to 0.7%.

Were the ends of the arch buttressed, longitudinal expansion would manifest itself by a creasing, and the strains inside the bricks result in ruptures.

In foundry furnaces a space is often left between the refractory part and outer facing, and filled with compressible materials. Thus, in spite of expansion, the cracks are reduced in the exterior masonry.

Insufficient burning of the bricks may involve irregular expansion, as they may not have thoroughly shrunk before use.

The following table gives the different degrees of shrinkage in dessication, for different temperatures and compositions, according to Mr. Le Chatelier.

Burning Temperature.	Composition.	Linear Shrinkage %
1,410° C.	Pure clay	8.7
1,000° C.		3.2
1,280° C.		7
1,000° C.	Clay 30SiO ₂ . 65.5CaO ₃	0.4
1,280° C.		1.5
1,410° C.		4.7

It is much greater for pure clay than sandy mixtures. Nevertheless, and even in the latter case, it is greater in absolute value than linear expansion for a same degree of temperature. Defective burning of the bricks would thus involve fall of the arches. Consequently the bricks must always be burnt at the working temperature of the furnace.

I had occasion to estimate the shrinkage in burning of siliceous bricks with the following composition:—

It is easy to see that this vault was sure to fall. Its length (measured on the arc) before heating was 2.55 metres. and shrinkage on this length is 2.55 × 1.8 = 4.59 cms. In such circumstances, the length after heating becomes equal to the span. The arch tends to settle horizontally. Its own weight even determines a false pitch, and crumbling begins when the friction which kept the arch in place ceases.

Another anomaly in expansion of bricks is due to allotropic changes in the constituents of the refractory materials.

Thus, silica bricks become greatly inflated owing to transformation of the varieties of silica of great density, stable cold into varieties of slight density, stable hot. Here again this transformation should be brought about by the manufacturer of the refractory materials. The first phase in brickmaking should be calcination of the quartz.

Magnesia bricks would decrease in volume at about 1,600° C., were not the magnesia calcined at this temperature before manufacture.

When refractory materials are to be tested from the point of view of unchangeableness of volume, it is best to employ some of them for constructing the pillars of the arch, and thus ascertain how they act. This is preferable to separate heating. Sometimes, in fact, bricks heated separately crack and break as also they do in masonry work, but in the latter case, their junction with the other bricks prevents the cracks from extending excessively.

II. CONSTRUCTION AND ARMATURE.

When a furnace is heated for the first time the refractory part, heated directly, is sure to expand more than the exterior facing, heated only by conductivity.

Consequently the facing opposes expansion of the masonry, and there produces stresses, often considerable.

Were the exterior mass perfectly undeformable, the stresses would increase until they attained the limit of resistance of the crushing strength of the bricks. To avoid this result, which would, of course, involve rapid dislocation of the furnaces, the outer facing must be *sufficiently deformable* to be displaced under the influence of the stresses to which it is subjected, so as to allow for expansion.

On the other hand, the refractory materials must be *sufficiently resisting to crushing* not to give way under pressure.

To attain the latter result there must be no weak spots in the materials selected. Refractory structures are formed of bricks united by refractory mortar. Solidity of the bricks is due to the lamellar structure of the crude clay. At moulding the clay, the fibres intertwine and this state remains the same in desiccation. The refractory mortar, consisting of burnt clay, is in form of non-fibrous grains, which are not united and are much more compressible. The strains produced inside a furnace will therefore act chiefly in *rupture of the joints*.

Consequently, in building delicate parts like the arches, which might cave in through strains on the joints, endeavour should be made to *decrease the number and dimensions* of the joints. This is why, when possible, the arches should be built with large voussoirs instead of with a great number of small pieces like bricks.

The joints between the bricks should not be made as in ordinary masonry work, where they are often a centimetre thick. Joints in the flues should not exceed 4 mm., and to build them properly a skill is required not generally possessed by the ordinary chimney builder.

The *cutting of bricks* should be avoided as much as possible. When not carefully executed this operation produces uneven surfaces involving thick joints. It is an advantage, for example, to make the arch springers with special pieces. The most delicate joints are those in the furnace arch. The bricks are often laid dry on a wooden centreing, and then a very fluid mortar is run into the joints, the centreing being removed after setting. Good assemblage of the bricks is also assured, and also a thin joint, by dipping the surfaces to be united in a fluid mortar, and then grinding these surfaces by rubbing them together. Thicker joints can be tolerated in the outer masonry, which must be deformable, than in the refractory part. Deformation then partially manifests itself by a compression of the joints.

By working in this way the two important factors which we previously specified, are ensured, viz., resistance to the crushing stress of the refractory mass and a sufficient deformability of the brick facing.

In spite of all these precautions, these ideal conditions are never completely realised. The pressure developed inside the masonry is not equal in all places. Consequently, when firing the furnace this difference in the pressure and resistance produces cracks on the exterior, especially in the brick joints which, as we said, are weak points. The extent of the cracks produced at firing is not usually proportional to the degree of expansion. There are general movements in the mass (sliding, rotation) which increase the cracks. It is also to be noted that when a furnace is extinguished the cracks do not close completely, and they become larger when the furnace is again fired.

The object of the armature is to keep these cracks within certain limits and ensure stability of the furnace.

Without armature a furnace would fall to pieces when fired. There are no general rules as regards this armature, which should be adapted, in each case, to the working of the furnace. A few examples will illustrate the most usual requirements. Supposing that a muffle furnace has to be furnished with an armature. The materials to be heated are placed on the hearth and separated from the products of combustion by the arch. The combustible gases of a producer or flames from a fire run through the passage in the arch to be then conveyed under the hearth through passages in the end walls and thence through the heating flues to the chimney or regenerator.

The delicate parts of a furnace are principally the arches, which must be carefully armatured.

The following calculation shows that surbased arches can be dislocated even with a slight width between the supports.

An arch A.B., at the ordinary temperature, has a span of 2.50 metres and rise of 0.25. Radius $R = 2(1.25^2 + 0.25^2) = 3.25$ metres. The angle α is 22.5° , and the angle in the centre 2α , intercepting the arc AB, is 45° . Thus arc AB = $\frac{\pi \times 3.25 \times 45}{180} = 2.551$ metre. From the ordinary temperature of $1,000^\circ\text{C}$. expansion of the fireclay bricks is about 0.7% of the initial length. The length of the arc after expansion will be 2.568, the difference in the span before and after expansion being less than 2 centimetres.

Everything tending to make this difference greater must be avoided. When we consider that the compression of the joints on the exterior facing may attain 1 centimetre in each wall, we can see that there is not a great guarantee of safety.

In constructing surbased arches similar to those of a muffle furnace as described *transversal expansion must be prevented* in the arches, which should undergo expansion *in form of a greater rise* in the arch.

To attain this result the masonry of the arch walls must support enormous thrusts without displacement. Consequently, the armature must be fixed in these places. Usually the thrusts of surbased arches are collected and uniformly distributed over the mass with U irons placed on a level with the arch abutments and of the same height as the latter.

These U irons transmit the stresses to double U girders fixed vertically in pairs against the outside of the masonry, and anchored in concrete at the base. Above the furnace they are braced together with tie-rods bolted on reinforcing plates encircling each pair of girders. Thus a perfectly undeformable system is realised.

The depth of anchorage in the ground is 50 to 70 cm. The concrete should prevent displacement of the armature at the base. Sometimes it has to be consolidated at time of firing the furnace. Diameter of the tie-rods depends upon the distance of two girders from each other. For slight lengths ($3\frac{1}{2}$ to 4 metres) this diameter is 25 mm., and when long, the rods are often made in two parts with a hook at each end to link them together. Soldering is not suitable, unless very carefully executed, as it constitutes a weak part which often gives way.

The number of girders on the length of a furnace depends largely upon the way the masonry works. Iron must never be spared. Unfortunately the methods of calculation which could solve the problem cannot be applied for want of coefficients. We must depend upon practical experience.

When a new furnace is fired defects in the armature

can be noted if it bends under the thrusts to which it is subjected. In this case more armature must be added, or the profile changed.

In many furnaces utilised in the chemical industry the armature is formed with old rails. This is an economic process which enables a greater armature to be made.

In a muffle furnace, as we have seen, the *armature must be rigid transversally*, so that the expansion of the arches will not increase the span but the rise.

Lengthwise, on the contrary, expansion can only be linear, and it would be dangerous to try to prevent it, as this would cause internal stresses in the masonry of the arch, producing serious deformation, creases and final dislocation. Consequently, in this direction, the extremities of the arch should not abut. There should be a space 0.5% of the length of the arches at the extremities in furnaces working at 500° C.; in furnaces for 1,000° C. and more a space of 1% is not too much. Here, for the same reasons, the armature must be *deformable*. Some builders employ Belleville washers to bolt the tie-rods on the girders. In my opinion, the use of these washers is often justified for parts of the armature which must be pliant. In the preceding example Belleville washers would be an advantage for longitudinal tie-rods, but dangerous on the transverse ones.

These considerations upon the way iron armature should work should be remembered when deciding how the tie-rods must be tightened on the armature when firing the furnace. The rods to resist tensile stress should be locked at firing the furnace, whereas the rods which have to yield to thrusts must be loosened, as they gradually stretch.

Tension of a rod is ascertained from the sound it emits when struck with a hammer, or yet better, from the muscular effort necessary to loosen it. Experience is necessary for this, and management of the rods should always be entrusted to the same men, who should always use the same keys.

An almost infallible method is to maintain such a tension that the rod can easily be tightened, and turn the nut once, for example, with a key 50 cm. long.

After tension, the rods are loosened so as to return to this state. Circular furnaces, like some gas producers, Herreshoff furnaces for roasting pyrites, have not any armature like that described. They are completely enclosed in a plate armature or flat iron hoops placed on a level with the thrusts.

BOOKS, ETC., RECEIVED.

"India-Rubber Laboratory Practice," by W. A. Caspari. Macmillan & Co., Ltd., London, 1914. Pages 196 + viii. Price 5/- net.

"Intermetallic Compounds," by C. H. Desch. Longmans Green & Co., 1914. Pages 116 + vi. Price 3/- net.

"The Co-operation of Science and Industry," by S. Roy Illingworth. Charles Griffin & Co., Ltd., London, 1914. Pages 91 + viii. Price 1/6 net.

"Laboratory Manual of Glass-Blowing," by Francis C. Frary. The Hill Publishing Co., Ltd., London, 1914. Pages 60 + vi, including Index. Chapters V., with 18 Illustrations. Price 3/2 net.

"Mechanical Refrigeration," by H. J. Macintire. Chapman and Hall, Ltd., London, 1914. Pages 346 + ix. Price 17/- net.

ENGINEERING NOTES.

By R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

Another Petrol Substitute.

It appears that quite a successful petrol substitute can be manufactured by carburetting steam with heavy tar and coke oven oil residues at about 360° C.

The process essentially consists of heating the heavy residues to somewhat above the temperature mentioned, bubbling dry steam at that temperature through them and then passing the steam and oil vapour so obtained through a series of heated nickel tubes. The nickel acts as a catalyte starting an action, whereby the hydrogen of the steam is given up to the oil vapour, transforming what was at first the vapour of a heavy high carbon oil into that of a light high hydrogen oil. It is claimed that nearly half of the original, practically waste, oil can be converted to a light and thermodynamically useful oil in this manner, and that the residue diluted with fresh waste oil can be retreated in the same fashion until (after a time) nothing but a highly carbonaceous pitch is left at the "heavy end."

Professor Vernon Boys has spoken very highly of the motor value of this light product, and from the change in composition its thermal value must be greatly augmented.

Several points arise, however, which may render this article less interesting to the manufacturer and buyer than it otherwise might be.

Nickel tubes are expensive things, or even heated nickel wires; and no mention is made of the rate at which these may be expected to corrode or stale. Further, the supply of the heavy residue is likely to be very limited, unless the reaction can be successfully carried out, with the substances named earlier in this article, near their pitching point.

If, however, this can be successfully and cheaply done, having regard to running costs of the apparatus, a new and profitable field should be opened to the tar distilling industry.

An Ingenious Locomotive.

A short notice appeared in the Engineering Supplement of *The Times* about the middle of February, regarding a very ingenious works haulage locomotive for use in factories dealing with inflammable materials such as timber or certain chemicals.

The locomotive under present consideration is at work in the factory of the National Cash Register Company, of Dayton, Ohio. The method of working is as follows: A large cylindrical tank like the boiler of an ordinary loco. but without firebox, tubes, or other usual appurtenances, of about 350 cu. ft. capacity, is half-filled with water. Into this is injected live dry steam at a pressure of 150 lbs., until the resulting internal pressure has risen to the same figure and the water to about three-quarters of the total internal capacity (by condensation); the injection steam is then cut off and the loco. worked in the ordinary way through a reducing valve giving at the outset 60 lbs. per square inch pressure steam to suitably larger cylinders than those usually employed for higher pressures.

The locomotive is clearly free from all danger of giving off sparks.

It is stated that the time of charging is 12 to 15 minutes, and as it pointed out this can be done at the company's power station where steam can be generated for this or any other purposes under the most favourable conditions.

The weight of the engine after charging is said to be about 33 tons, and the period of useful working two to three hours; the engine is capable of giving out useful work at 10 lbs. to the square inch pressure.

The engine has a fair claim to economy, owing to the conditions under which the steam is generated, and its suitability to the conditions is easily apparent; but it is also very evident that only a very large and well-equipped plant could make suitable use of such a machine, and that it is completely out of the field as far as small or medium-sized works are concerned.

General Management.

By the time this article appears in print, the excitement and apparent annoyance caused by the appointment of an American to the post of General Manager of one of the great railway systems of this country will probably have completely died down, and been almost forgotten by all but the most closely interested.

Seeing that Englishmen in general are never so happy as when crying themselves down and pointing out how much better France, Germany, and America do everything than they themselves do, the outburst which this appointment caused in the British press about the end of February was rather remarkable—this, however, is all by the way.

The point seems to be that the requisite training for general managers is changing with the times, and this applies to large factories about as much as to railway companies. If an analogy from the State may be permitted, it can be pointed out that in the past, the king or head of a tribe, whether he was a herdsman, a hunter, or a warrior, was wont to absorb in himself all the functions of government; coming to our own country and times not so remote, the king and a parliament governed, and the officers of this parliament were usually the heads in fact, and not chiefly the mouthpieces of their departments. To-day they are mainly the mouthpieces and the permanent officials of their departments the source of the analysis and collection of the information with which the department deals.

The comparison need not be pressed too far, but the analogy is plain enough, and applied to works it comes to this: It is not possible nowadays in any long established and large or even moderate-sized undertaking, for the general manager to be as good as or better than everybody under him at every several separate job, or better than a man of fair industry and intelligence who may have spent the best part of his life on that particular form of work.

Unfortunately, a great many general managers do not fulfil all the conditions they might, while being no more than the above paragraph indicates, and while they may be, and often are, experts in one direction in which the output of the factory or business moves, they frequently have scarcely a nodding acquaintance with a great many of the others.

The specialisation and organisation, which is the rule (and as it seems to the writer the inevitable rule under modern competitive conditions) has this drawback, that while it produces more capable, efficient, and at the same time easily replaceable departmental heads, it militates very strongly against the development of the general manager proper.

The solution of the difficulty seems, however, to be by

no means impossible if it be clearly realised and provided for; it has its risks, but in the opinion of the writer, it would also produce its general managers.

The method of operation with modifications might be somewhat as follows:—

At any given time in a large works, a limited number of men with first-class degrees in those branches of learning particularly adapted to their future employment might be taken on, and being given at the start a clear idea of what was expected of them, carefully taken through every department of the business, beginning at the manual end and finishing in the assistant positions in the more important executive branches—this would by no means be equivalent of the present system of "serving one's time," and incidentally would take three or four times as long, say ten to twelve years.

The disadvantages of the present system are that general managers of large transport or manufacturing concerns generally come from one side of the proposition, and are apt to regard the other either as much easier or much harder to manage than it in fact is. The advantages of the above system are that this state of things would be avoided, and while it would not prevent the genuine genius not initially "picked" from rising, it should prevent the spurious one and the merely "clever mechanic" from getting into positions for which they were not suited. The length of the training and its diversity would soon show up general capacity in the capable, and weak spots in those less so.

It only remains to add that a living wage with reasonable rises from the start would be "a policy of intelligent selfishness," and that the writer's pious conviction is that plenty of men would be found to fill the bill.

HISTORICAL CHEMISTRY.

THE ALCHEMISTS.

IN view of the increasing attention now paid to the work of the alchemists, it is interesting to consider the position of chemistry and the relations existing between its votaries before the foundation of the Royal Society (1660). This is well illustrated by the following extracts from the foreword—"To the Reader"—in "The Art of Distillation," by John French, Dr. of Physick, (1651).

Commencing, he says: "There is a glut of Chymicall books, but a scarcity of chymicall truthes"; and, after apologising mildly for his own shortcomings and those of his work, continues,—“I rejoyce as at the break of the day after a long tedious night, to see how this solary art of Alchymie begins for to shine forth out of the clouds of reproach, which it hath a long time undeservedly layen under. There are two things which have a long time eclipsed it, viz. the mists of ignorance, and the specious lunary body of deceit. Arise, O Sunne of truth, and dispell these interposed fogs, that the Queen of Arts may triumph in splendour! If men did beleewe what this Art could effect, and what variety there is in it, they would bee no longer straightened by, nor bound up to or *Iurare in verba Galeni, vel Aristotelis*, but would now subscribe a new engagement to be true and faithfull to the principles of *Hermes*, and *Paracelsus*, as they stand established without *Aristotle* their prince, and *Galen*, and *Hippocrates*, their lords and masters. They would no longer stand dreaming forth, *Sic dicit Galenus*, but *Ipse dixit Hermes*. I desire not to be mistaken as if I did deny *Galen* his due, or *Hippocrates* what is his right, for indeed they wrot excellently in many

things, and deserved well thereby; that which I cannot allow of in them is their strict observation of the quadruplicity of humours (which in the schoole of *Paracelsus*, and writings of *Helmont*, where the anatomy of humours hath been most rationally and fully discussed, hath been sufficiently confuted) and their confining themselves to such crude medicines, which are more fit to be put into Spagyricall vessels for a further digestion, then into mens bodies to be fermented therein. Certainly if men were lesse ignorant they would preferre cordiall essences before crude juices, balsamicall Elixirs before flegmatick waters, the Mercury of philosophers before common quicksilver. But many men have so little insight in this Art, that they scarce believe anything in it beyond the Distilling of Waters, and Oils, and extracting of Salts; nay many that pretend to Philosophy, and would be accounted Philosophers, are so unbelieving, that, as saith *Sandivogius*, although he would have intimated the true Art to them word by word, yet they would by no meanes understand or beleve that there was any water in the Philosophers sea. And as he in this case so I in another know divers that will not beleve that common quicksilver can of it selfe be turned wholly into a transparent water, or that glasse can be reduced into sand and salt of which it was made, saying that *fusio vitrificatoria est ultima fusio*, or that an hearb may be made to grow in two hours, and the Idea of a plant to appear in a glasse, as if the very plant it selfe were there, and this from the essence thereof, and such like preparations as these: the two former whereof may be done in half an hour, but the latter requires a long time, but yet possible. And for the possibility of the Elixir, you shal as soon perswade them to beleve they know nothing (which is very hard, nay an impossible thing to doe) then to beleve the possibility thereof. If there be any such thing (say they) why are not the possessors thereof infinitely rich, famous, doe many miracles and cures, and live long. These Objections especially some of them, scarce deserve an answer; yet I shal to shew the vanity of them make some reply thereunto. Did not *Artesius* by the help of this medicine live 1000 yeares? Did not *Flammell* build fourteene Hospitals in *Paris* besides as many in *Boleigne*, besides Churches, and Chappels with large revenewes to them all? Did not *Bacon* doe many miracles? and *Paracelsus* many miraculous cures? Besides what faith *Sandivogius*? I have saith he incurred more dangers, and difficulties by discovering my selfe to have this secret, then ever I had profit by it, and whensoever I would discover my selfe to the great Ones, it alwayes redounded to my prejudice, and danger. Can a man that carrieth alwaies about him 10000 pounds worth of Jewels and gold, travel every where up and downe, safe, and not be robbed? Have not many rich money-mongers been tortured into a confession where their money was concealed? Did you never heare of a vapouring fellow in *London*, that pretending to the knowledge of this Mystery was on a suddaine caught aside by money-thirsters, and by them tormented with tortures little lesse then those of hell, being forced thereby (if he had knowne it) into a discovery of it? To say nothing of being in danger of being subjected, and enslaved to the pleasure of Princes, and of becoming instrumental to their luxury, and tyranny, as also being deprived of all liberty, as once *Raimundus Lullius*. The truth is, the greatest matter that Philosophers aime at, is the enjoyment of themselves, for which cause they have sequestered themselves from the world, and become *Hermities*: Well therefore and like a philosopher spake *Sandivogius*, when he said, Beleeve me, if I were not a man of that

state and condition that I am of, nothing would be more pleasant to me, then a solitary life, or with *Diogenes* to live hid under a tub; for I see all things in this world to be but vanity, and that deceit, and covetousnesse prevaile much, that all things are vendible, and that vice doth excel vertue. I see the better things of the life to come before mine eyes, I rejoyce in these: Now I doe not wonder, as before I did, why Philosophers when they have attained this medicine, have not cared to have their daies shortned, (although by the vertue of their medicine they could have prolonged them) for every Philosopher hath the life to come so cleerly set before his eyes, as thy face is seen in a glasse. Thus much by way of reply to the frivolous objections of those that beleve not the verity of this Art, and not onely so, but wil not beleve it. If you should discover to them the processe of the philosophers stone, they would laugh at your simplicity, and I wil warrant you never make use of it. Nay if you should make projection before them, they would think that even in that there were a fallacy, so unbelieving are they: so I finde them, and so I leave them, and shal for ever finde them the same.

"There is another sort of men by whom this Art hath been much scandalized, and they indeed have brought a great Odium upon it by carrying about, and vending their whites, and reds, their sophisticated oils, and salts, their dangerous and ill prepared *Turbithes*, and *Aurum vitæ's*. And indeed it were worth while, and I might doe good service for the Nation, to discover their cheats, as their sophisticating of Chymical oils with spirit of Turpentine, and salts with salt extracted out of any wood-ashes and such like, but here is not place for so large a discourse as this would amount to. I shal only at this time relate to you how, *Penotus* was cheated with a sophisticated Oil of gold, for saith he I gave 24. duckets for the processe of an *Aurum potabile* which was much cryed up and magnified at *Prague*, but at last it proved to be nothing but a mixture of oil of Camphire, Cloves, Fennel-seed, and of Vitriol tinged with the leaves of Gold. I know I shall incurre the displeasure of some, but they are sophisticating, cheating mountebanks, who indeed deserve to be bound to the peace, because many men, I dare swear, through their means go in danger of their lives. Better it is that their knavery should be detected, then a noble Art through their villany be clouded, and aspersed.

"Now we must consider that there are degrees in this Art; for there is the accomplishing of the Elixir itself, and there is the discovering of many excellent essences, magisteries, and spirits, etc., which abundantly recompence the discoverers thereof with profit, health, and delight. Is not *Paracelsus*, his *Ludus* that dissolves the stone, and all tartarous matter in the body into a liquor, worth finding out? Is not his *Tinea Scatura* a most noble medicine, that extinguisheth all preternatural heat in the body in a moment? Is not his *Altahest* a famous dissolvent, that can in an instant dissolve all things into their first principles, and withall is a specificum against all distempers of the liver? who would not take paines to make the quintessence of honey and the philosophicall spirit of wine, which are cordial and balsamical even to admiration? A whole day would fail to reckon up all the excellent, admirable rarities that by this spagyricall Art might be brought to light, in the searching out of which, why may not the Elixir it selfe at last be attained unto? Is it not possible for them that passe through many philosophical preparations to unfold at last the riddles, and Hieroglyphicks of the Philosophers? or were they all meer Phantasmes? Is there no *fundamentum*

in re for this secret? Is there no sperme in gold? is it not possible to exalt it for multiplication? Is there no universal spirit in the world? Is it not possible to finde that collected in one thing, which is dispersed in all things? What is that which makes gold incorruptible? What induced the Philosophers to examine gold for the matter of their medicine? Was not all gold once living? Is there none of this living gold, the matter of Philosophers, to be had? Did *Sandivogius* the last of knowne Philosophers spend it all? Surely there is matter enough for Philosophers, and also some Philosophers at this day for the matter, although they are unknowne to us. There are, saith *Sandivogius*, without doubt many men of a good conscience both of high and low degree (I speak knowingly) that have this medicine, and keep it secretly. If so; let no man be discouraged in the prosecution of it, especially if he take along with him the five Keyes which *Nollius* sets down, which indeed all Philosophers with one consent enjoyne the use and observation of.

"1. Seeing it is a thing divine, and celestial, it must be sought for from above, and that not without a full resolution for a pious, and charitable improvement of it.

"2. Before thou betakest thy selfe to the worke, propound to thy selfe what you seekest for, and enter not upon the practicke til thou art first wel versed in the theory, for it is much better to learn with thy braines, and imagination, then with thy hands, and costs, and especially study nature wel, and see if thy proposals be agreeable to the possibility thereof.

"3. Diligently read the sayings of true philosophers, read them over again and againe, and meditate on them, and take heed thou doest not read the writings of imposters instead of the Books of the true Philosophers. Compare their sayings with the possibility of Nature, and obscure places with cleare, and where Philosophers say they have erred doe thou beware, and consider wel the general axioms of Philosophers, and read so long til thou seest a sweet Harmony, and consent in the sayings of them.

"4. Imagine not high things, but in all things imitate nature, viz. in matter; in removing what is Heterogeneous; in weight, in colour; in fire; in working; in slownesse of working; and let not thy operations be vulgar, neither thy vessels; work diligently and constantly.

"5. If it be possible, acquaint thy selfe thoroughly with some true Philosophers. Although they wil not directly discover themselves that they have this secret, yet by one circumstance or another it may be concluded how neer they are to it. Would not any rational man that had been conversant with *Bacon*, and seeing him doe such miraculous things, or with *Sandivogius* who did intimate the Art to some word by word, have concluded that they were not ignorant of it? There have been Philosophers, and perhaps stil are, that although they wil not discover how it is made, yet may certifie you, to the saving of a great deal of cost, pains, and time, how it is not made: and to be convinced of an error is a great step to the truth. If *Ripley* had been by any Tutor convinced of those many errors before he had bought his knowledge at so deare a rate, he had long before, with lesse charges attained to his blessed desire.

"And as a friendly Tutor in this, so in all spagyricall preparations whatsoever, is of all things most necessary. A faithful wel experienced master wil teach thee more in the mysteries of Alchymie in a quarter of a year, then by thine owne studies and chargeable operations thou shalt learn in seven years. In the first place therefore, and above all things apply thy selfe to an expert, faithful, and com-

municative Artist, and account it a great gain, if thou canst purchase his favour, though with a good gratuity, to lead thee through the manual practice of the chiefest, and choisest preparations. I said apply thy selfe to an Artist, for there is scarce any processe in all Chymistry so easie that he that neer saw it done wil be to seek, and commit some errors in the doing of it. I said expert, that he may be able to instruct thee aright, faithful; that as he is able, so may faithfully performe what he promiseth; and communicative, that he may be free in discovering himselfe and his Art to thee. The truth is, most Artists reserve that to themselves, which they know, either out of a desire to be admired the more for their undiscovered secrets or out of envie to others knowledge. But how far this humour is approvable in them, I leave it others to judge; and as for my part I have here communicated upon the account of a bare acceptance onely what I have with many years paines, much reading, and great costs known. There is but one thing which I desire to be silent in as touching the processe thereof; as for the thing it selfe to be prepared, what it is I have else where in this Treatise expressed; and the preparing of that is indeed a thing worth of any ones knowing, and which perhaps hereafter I may make knowne to some. I am of the same mind with *Sandivogius*, that that fourth Monarchy which is Northerne, is dawning, in which (as the ancient Philosophers did divine) all Arts and sciences shal flourish, and greater and more things shal be discovered then in the three former. These Monarchies the Philosophers reckon not according to the more potent, but according to the corners of the world, whereof the Northerne is the last, and is indeed no other than the golden age, in which all tyranny, oppression, envie, and covetousnesse shal cease, when there shal be one prince and one people abounding with love and mercy, and flourishing in peace: which day I earnestly expect.

"JOHN FRENCH."

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, *Chartered Patent Agent,*
Queen Anne's Chambers, Westminster, S.W.

14509/13. BADISCHE ANILIN AND SODA FABRIK. **Hydrogen.**

Hydrogen is freed from sulphur, whether free or combined, by heating it, or gases containing it, with a solution of caustic alkali under pressure exceeding a pressure equal to that of five atmospheres.

15629/13. H. J. S. SAND. **Refractory Vitreous Substances.**

Refractory vitreous substances, such as quartz glass, are manufactured by enclosing refractory, vitreifiable, or vitreous, substances in a refractory vitreous envelope or receptacle, removing the air or gases, and heating and collapsing the envelope or receptacle on to the enclosed substance.

18890/13. C. C. MOORE and W. TRANTOM. **Treating Hides.**

Hides are treated before tanning with sodium chloride free or substantially free from calcium and magnesium compounds and sodium sulphate.

27317/13. M. HOENICKE and H. A. BERENS. **Camphor.**

A process for producing camphor *via* camphor nitrate, consists in treating pinene hydrochloride, hydrobromide or hydroiodide or an oily mixture containing same with nitric acid, its salts or a mixture of both, water being subse-

quently added if necessary to decompose the camphor nitrate.

28524/13. DETTIFOSS POWER CO., LTD. and J. H. LIDHOLM.

Calcium-cyanamide.

Calcium-cyanamide is produced from calcium carbide and nitrogen by introducing successively small quantities of the carbide into a furnace chamber heated to a high temperature and supplied with nitrogen in such manner that the freshly introduced carbide falls down on the carbide acted upon by reaction and is heated by its heat of reaction, the finished block of calcium cyanamide being removed all at once from the chamber of reaction.

18102/13. SIEMENS AND HALSKE AKTIENGESellschaft.

Electrolysis.

In effecting the electrolysis of alkali-halides on the "horizontal diaphragm principle," the hydrogen evolved in and filling the cathode space is maintained at a pressure above atmospheric pressure for the purpose of counteracting partly the hydrostatic pressure of the electrolyte situated above the diaphragm, and thus regulating the speed of filtration.

25029/13. FARBENFABRIKEN, VORMALS FRIEDRICH BAYER & Co. **Process for Producing Yellow Azodyes.**

26498/12. E. HEILMANN. **White Enamel.**

In the manufacture of white enamels there is used as a clouding agent a mixture of magnesium oxide and aluminium oxide or of zinc oxide and aluminium oxide previously calcined at such high temperatures as to form spinels, or a solid solution of magnesium spinel in magnesium oxide or aluminium oxide or of zinc spinel in zinc oxide or aluminium oxide.

28660/12. V. HENRI, A. HELBRONNER and M. VON RECKLINGHAUSEN. **Sterilising Liquids.**

Apparatus for sterilising liquids by means of ultra-violet rays comprises a lamp having a substantially U-shaped container with its electrodes arranged closely adjacent to one another.

28973/12. J. ROSEN.

Improvements in the conversion of coal-tar, petroleum residues, creosote, Schist Oils and the like into pitch.

731/13. H. ZERNING. **Process for Converting Mineral Hydrocarbons (Petroleum and the like) into Oils having a Lower Boiling Point.**

1851/13. A. H. LYMN. **Ammonia.**

In this process for the recovery and utilisation of ammonia from gas manufacture, the ammonia in the gas is brought into contact with uncombined nitrogen oxides or oxyacids obtained by combustion with nitrogen and oxygen of gas which has already been freed from ammonia.

2486/13. THE ELECTRIC SMELTING AND ALUMINIUM CO. **Di-calcium Phosphate.**

Di-calcium phosphate is produced by treating tri-calcium phosphate containing substances with hydrochloric and sulphuric acids.

2728/13. A. BURROWS and J. CHARLTON. **A Method of and Means for Simultaneously Cooling Producer Gas and Manufacturing Salt by the Evaporation of Brine.**

3138/13. F. O. MOTT, J. PRICE and E. W. JODREY. **Improvements in Apparatus for Preparing Milk Cultures.**

3413/13. G. RENARD. **Process and Apparatus for the Transformation of Petroleum and similar Hydrocarbons into Products having a Lower Boiling Point.**

5150/13. J. CANELLO. **Tungsten.**

In a process for the production of bodies of tungsten

and other refractory metals, the finely divided metal is mixed with a small quantity of nickel together with glycerine to act as a binding agent, and the mixture is then compressed, slowly dried, and sintered in an electric oven.

5754/13. E. V. CHAMBERS, T. C. HAMMOND and G. G. JARMAN. **Treating Trade Effluents.**

A treatment of trade effluents for the recovery of grease consists in first subjecting the effluent to the action of washed or scrubbed flue gases in a closed vessel, the effluent then passing into an open vessel, into which air or liquid drawn from the closed vessel, alone or along with air or washed flue gases, is then forced to cause separation of the grease in the form of a froth or foam which is delivered to collecting or settling tanks and afterwards subjected to heat.

6668/13. A. L. C. NODON. **Cellulose.**

A process for rendering cellulose imputrescible, and also for increasing its mechanical strength, consists in first impregnating superficially the cellulose with water or a saline solution, and then subjecting it to the prolonged action of an electric current.

8166/13. G. GIULINI. **Aluminium.**

A process for the production of aluminium from its compounds, such as alumina, by reduction with carbon alone, consists in heating the reaction mixture to a high temperature out of contact with air so that the aluminium is volatilised, the mixed vapours being drawn by means of a vacuum pump into a cooling chamber wherein the aluminium vapour is condensed.

8684/13. H. C. COSWAY and THE UNITED ALKALI CO., LTD. **Improvements in and relating to the Manufacture and Production of Nitration Products from Coal Tar.**

8782/13. BADISCHE ANILIN AND SODA FABRIK. **Isoprene.**

Isoprene is produced by treating vaporised 2-methyl-butenol ethers with a reagent which will split off water catalytically.

11091/13. SOCIÉTÉ GÉNÉRALE DES NITRURES. **Nitrides.**

A process for the manufacture of nitrides, such as aluminium nitride, by the method which consists in heating in presence of nitrogen or of gases containing the same, a mixture of carbon and alumina is characterised by the fact that there is caused to advance in a continuous electrical furnace a mixture of these materials containing an excess of carbon sufficient to ensure the passage of the current in spite of the losses due to the reaction.

11167/13. J. DE COMO and H. QUINAUX. **Improved Liquid Fuel.**

A method of manufacturing liquid fuel consists in dissolving in mineral oil a substantial proportion of naphthalene by means of the addition of nitro-naphthalene or naphthylamine or both and cresol, or of suitable homologues or derivatives of these substances.

12377/13. THE BRITISH THOMSON-HOUSTON CO., LTD. **Stable Boron Nitride.**

Stable boron nitride is produced by heating unstable boron nitride to a temperature of about 2,000° C. or higher.

14003/13. L. DUMONS. **Nitrating Cotton.**

A process of nitrating cotton *in vacuo* consists in circulating the sulphonitric liquid through a mass of cotton in the midst of which a vacuum has been previously created, the vessel containing the cotton being in communication with a vacuum chamber which receives the active liquid after it has traversed the mass of cotton with the effect of nitrating to the same extent the whole mass of cotton to be treated.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

Iodine in Siberia.

A project to establish a large iodine factory at Olga Bay, in Siberia, has been abandoned, although the Russian firm which, previous to planning the factory, made extensive experiments, found that iodine exists in commercial quantities in seaweed at Olga Bay. It is said that this concern sold out whatever interest it had to a German chemical company that wished to limit competition.

Flavouring Extract Alcohol Bill.

At the suggestion of the flavouring extract manufacturers of Baltimore, a Bill has been introduced in the American Legislature which would put flavouring extract manufacturers on the same plane with the manufacturers of drugs and other goods in the production of which alcohol must be used as a percolating medium. Under the present statute, the alcohol used by the manufacturers of drugs as a percolating medium can be recovered and used again without taxation. Manufacturers of flavouring extracts, however, are not permitted to use the alcohol thus recovered without payment of a tax.

The Institute of Industrial Research at Washington.

The Institute of Industrial Research, Washington, D.C., has issued a bulletin giving details of its scope and organisation. It was founded by Allerton S. Cushman, Henry A. Gardner, and N. Monroe Hopkins, December 1st, 1910, as a company incorporated under the laws of Columbia. The objects are to investigate and improve processes of manufacture, to co-operate with manufacturers in the reduction of costs and the utilisation of by-products and waste. The training and instruction of graduates of scientific schools and other qualified persons in industrial research is another object of this useful institution.

Potash Salts in Germany.

A report on the production of potash salts in Germany since the year 1890 has recently been issued. In that year the output amounted to 12,790,645 doppelzentner, rising to 34,846,945 doppelzentner in 1901, declining to 32,508,346 doppelzentner in 1902, then progressing without a setback to 110,700,143 doppelzentner in 1912. This progress has taken place in comparative calm; there has been no outside competition, except in the form of efforts on the part of the Americans to get hold of a large share of the business by investing money in it, and making good contracts. They were defeated by what amounted to special legislation. In the course of twenty-two years, the demand for and the production of potash salts increased ninefold. About 90% of the output is used for agricultural purposes, and the balance in other industries. The countries that have used most, taking 1912 as a guide, were Germany, followed by the United States, Holland, France, Russia, Sweden, Austria, and England. Austria would probably stand

higher up in the list, only she mines a fair amount of mineral potash herself, although her potash fields are too restricted to constitute a menace to Germany's natural monopoly.

New Oxygen Works in France.

The rapid strides which the oxygen industry is making in France is proved by the great activity in producing circles. For example, the "Oxhydrique Française" is building two large oxygen works in the north and east of France. The company "L'Air Liquide" is also erecting three factories in the north-east and in the central part of the country. Furthermore, the same firm has built new works in Algiers. In addition to the above-mentioned concerns, the firm of Ledoux, of Bordeaux, is interested in the construction of an oxygen factory at Maubeuge, and, finally, a new company has been formed at St. Etienne, with a capital of 120,000 francs, the object of which is the production of oxygen and hydrogen by means of hydro-electrolysis.

Soda Lakes in Mongolia.

The *Deutsche Japan-Post* contains a report from Peking according to which large quantities of natural soda have been discovered in the lakes and marshes of Mongolia, especially in the east of Central Mongolia. Several attempts have been made to exploit the discovery, particularly in the district of Tscheng-tschia-jung, but the complete absence of means of transport and the lack of skill among the native population, have frustrated these efforts. The report emphasises the fact that the importation of artificial soda into China is on the increase, and that now the question arises whether the recently discovered deposits in Mongolia could diminish these imports. Such a possibility seems, at present, rather remote, owing to the great difficulties of regular exploitation; but, on the other hand, the growing prosperity of China will sooner or later induce foreign or home capitalists to have the soda deposits thoroughly investigated in order to determine their possibilities.

Free Importation of Sandalwood and Orris Root in America.

Of great interest to exporters of crude drugs to America is the ruling issued by the United States Treasury Department, upholding the contention of importers that importations of sandalwood and orris root, hitherto assessed for duty by the New-York appraiser at 20% duty under the provisions of paragraph 49 of the new tariff law, should be admitted free of duty as "crude drugs, unimproved in value or condition." The ruling of the Treasury Department on these articles, which is in the nature of an instruction to the Collector of Customs at the port of New York, is made in response to an application made by the latter official asking for instruction on the score of these two commodities, and therefore contains no specific mention of the other similar articles, such as rose leaves, orange and cassia flowers, gum benzoin and styrax, which were mentioned in the application made to the Secretary of the

Treasury by an association of importers of essential oils. Inferentially, however, this ruling embraces these commodities as well as gum olibanum, which was recently added to the list of articles assessed at 20% by the local appraiser under paragraph 49 on the ground that they constitute "aromatic substances used in the manufacture of perfumes and cosmetics." The deputy collectors at the port of New York have agreed to admit all of the above enumerated articles free of duty, while assessing balsam Peru, heretofore taxed for import with the other commodities mentioned at 20%, at the rate of 10% specified for all balsams.

The Importation of Chemicals into British India.

The annual imports of chemicals and chemical preparations during the last five years into British India, show an increase of 25%. In the year 1908-09 the value of these imports amounted to £497,874, and in 1912-13 they reached £621,700. According to the *Review of the Trade of India* for 1912-13 the principal items of importation were as follows:—

	1911-12.	1912-13.	Increase or decrease.
	£	£	£
Sulphuric acid ..	33,000	25,000	— 8,000
Aluminous sulphates ..	17,000	31,000	+ 14,000
Bleaching materials ..	27,000	24,000	— 3,000
Carbide of calcium ..	9,000	10,000	+ 1,000
Disinfectants ..	25,000	26,000	+ 1,000
Cyanide of potassium ..	20,000	25,000	+ 5,000
Sodium bicarbonate ..	31,000	29,000	— 2,000
Sodium carbonate ..	105,000	75,000	— 30,000
Caustic soda ..	52,000	53,000	+ 1,000

The use of chemical manures is rapidly spreading in India, as the growing imports testify. The value of the imported chemical manures rose from £27,049 in 1907-08, to £27,981 in 1911-12. The imports from Germany alone increased during the above-mentioned period from £32 to £9,987.

The important trade in aniline dyes is principally in the hands of German manufacturers. The imports of this class of chemicals increased in 1912-13 by 26.4% in quantity, and by 28.2% in value. Switzerland is next in importance as exporter of aniline dyes to India, and the United Kingdom ranks fourth in the list. The importation of alizarine dyes is also growing rapidly, last year beating all previous records. Nearly all the bleaching materials imported in India originate from the United Kingdom, but German manufacturers have increased their share during the last few years.

Exhibit of Chemical and Pharmaceutical Industries at the Panama-Pacific International Exposition.

The exhibits from the chemical and pharmaceutical industries of the world will be shown in the Palace of Liberal Arts at the Panama-Pacific International Exposition in 1915, and their extent promises to be as inclusive as their variety will be instructive and interesting.

The diversity of these displays is seen in the fact that soaps and perfumes are scheduled under group 36 of the Exposition's book of classification, and so are apparatus and processes for the compression and liquefaction of gas.

Pyrotechnics, bombs, and signals, together with matches, will find a logical place in chemical relationship with the

by-products for pharmaceutical use obtained from treatment of petroleum and coal tar derivatives. The evolution of the den of an ancient alchemist will be seen in model laboratories of the present with complete equipment installed.

The extent of the industrial interests that are embraced in this department is disclosed in the statistical eloquence of the United States Census Bureau, which shows that there are 5,168 establishments devoted to the production of articles involved in the chemical and pharmaceutical arts, with an invested capital of \$419,930,000, employing 109,309 persons, earning \$73,491,000 and producing \$455,095,000 annually.

In connection with this exhibit it is expected that there will be carried on a most interesting series of public demonstration-exhibitions, for instance, of the research work carried out by the use of liquid hydrogen.

Another series of experiments that is calculated to prove as interesting in a popular way as important scientifically, will be the demonstrations devoted to the exposition of liquid air. These experiments, as prosecuted by Professor Dewar, have been reduced to the terms of popular understanding without rendering negative their scientific value.

Germany is another nation deeply interested in the exhibition; the more recent achievements in that country in the field of synthetic carbon chemistry, are largely responsible for the reputation popularly ascribed to Germany of being in the lead of all nations in individual chemistry.

M. L.

THE "THERMOFEED" DIFFERENTIAL PUMP GOVERNOR.

By J. G. DAVIS, B.Sc. (Eng.), A.C.G.I.

WHILST numerous types of control gear have been devised for the governing of prime-movers and certain machines driven by them through flexible and other couplings, the need for a simple and reliable means of automatically regulating the activity of steam or power-driven reciprocating pumps has long been felt.

The "Thermofeed" differential pump governor provides means for such a pump to control its own output within desired limits which have been predetermined by the engineer-in-charge, and assigned to the operation of the apparatus by a simple adjustment of the mechanism, causing the law of supply and demand to be obeyed in a manner which will secure a maximum of efficiency in the operation of the pump.

In construction and action this appliance, which is readily fixed to any existing pump, differs from any of the various electrical control gears which are devised for use with centrifugal pumping machinery, it being of small dimensions, self-contained, and purely mechanical in nature.

Whatever the "duty" of a pump, it reduces in all cases to supplying a certain volume of liquid in a given time to a given point, that is against a given pressure or "head," and in the ordinary non-governed pump the steam supply and mechanical action of the pump continue indefinitely after the duty has been accomplished and a predetermined pressure attained unless human agency checks them, and this clearly causes unnecessary increase in the working costs. Even if the attendant become aware that the demand has been met for the present, and stop the pump by shutting off the steam supply, his presence and

foresight again become a necessity to start the pump anew upon its work as soon as a certain pressure drop and the need for further supply of liquid call for this, otherwise the pumping system will fail to fulfil its duty and will be ineffective.

By means of the piece of apparatus above-mentioned, any steam-driven reciprocating pump can be reliably left to control of its own accord the periods of rest and activity necessary to maintain the water pressure in the pipe-line within fixed limits, which can be varied at will by the attendant engineer.

As is known, the "kick" or "throb" of a reciprocating pump, which we will call P, for convenience, exceeds the mean or working pressure p by several pounds per square inch, and in the case of this apparatus it is useful to note that the sensitiveness is such that an excess of pressure of some 3 lbs. per square inch above P is sufficient to actuate the mechanism and bring the pump to a stop, whilst by the simple adjustment of a gap existing between the central spindle and contact plate (appearing at about the centre of the illustration here given) the amount by which the pressure must exceed that demanded by the load in order to cause the pump to stop, can be increased to any desired extent.

The method by which this stopping is brought about is very simple. The lower part of the column shown on the left of the diagram is connected by a $\frac{1}{4}$ -in. pipe to the pump discharge main, so as to convey the main pressure to the upper face of a piston, which is enclosed in the upper part of the cylinder to which the name plate is attached in the illustration.

The upper portion of this cylinder and of the left-hand column is filled with cylinder oil. This forms a medium for conveying the fluid pressure, at the same time preventing actual contact of the water with the piston above described, and with the spiral steel spring which has its lower end bearing in a suitable recess in the fixed frame of the apparatus. The downward motion of the piston is resisted by the force opposed by the compression of the spring, which force is proportional to the motion. The pressure from the feed line is thus converted into mechanical movement, which, from its proportionality to this pressure, is readily employed as the agency for operating the mechanism controlling the steam supply, by means of suitable valves contained in the lower parts of the apparatus, which have now to be described.

The steam-valve proper is of the ordinary double-beat

pattern, and is contained in the spherical chamber in the direct steam supply line, shown at the bottom of the illustration, and in the absence of pressure from above upon the yoke attached to the two spiral springs this valve would remain permanently open, the action of these two springs as here arranged being an upward pull upon the valve-spindle, allowing steam to pass to the pump and actuate same.

The central enclosed part of the apparatus, however, contains the "Thermofeed" double valve which when pressed sufficiently downwards, permits steam to enter direct from the supply into a small cylinder situate directly below it, this steam acting upon a ring-piston. The latter is consequently depressed so that the central spindle attached to same, pushes the yoke above mentioned against its springs, so shutting off the steam supply by closing the double-beat valve as above described.

The starting control is effected by a circular plate attached to the spindle of the topmost or power piston engaging with projections attached to a curved trigger piece as soon as the lower pressure limit, at which the pump is required to start up again, is attained.

This trigger piece has hitherto held the control valve in its down or "shut" position, but as soon as the "trip" is caused by contact of this uprising plate on the main power cylinder spindle with the projections on the trigger gear, the small cylinder in connection with the ring-piston A is caused to exhaust its steam to atmosphere by the upward motion of the "Thermofeed" double valve, so relieving the downward pressure on the ring piston, and on the spindle of the steam valve.

This allows the latter to rise under the action of its springs, and to again admit steam to the pump at the instant when it can advantageously continue its work.

The makers of the apparatus, Messrs. Ronald Trist & Co., Ltd., claim entire reliability with the accurate workmanship necessary to the manufacture of any such appliance, and it would appear that in the field above indicated, there is considerable scope for its application.

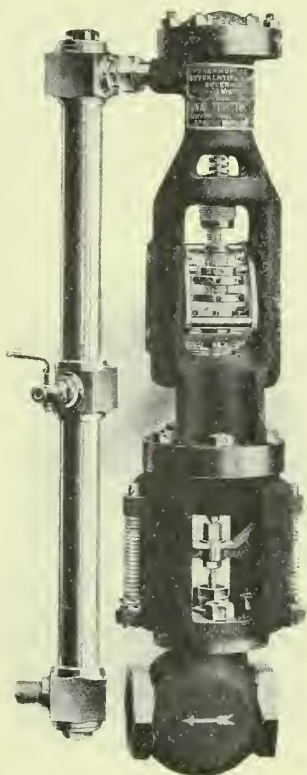


FIG. 1.

CONSULAR REPORTS.

Fertilisers in the Netherlands.

Reporting upon the economy in the use of fertilisers in Holland, Vice-Consul-General De Young, writing from Amsterdam, gives an account of the fertilisers used, and the cost thereof, as follows:—

The kind and amount of fertiliser used in the Netherlands depends entirely on the nature of the soil, just as it does in other countries. In bulb raising, the sand is removed down to the level of the peat, the latter being exposed to the frost, which crumbles it; and an excellent garden mixture results from mixing it with sand and manure. In the grazing districts, liquid manure and lime are used to a large extent. In some sections a mixture of 30 cwts. of superphosphate, 20 cwts. of kainit, and 6 cwts. of nitrate is used per acre. Often as much as £4 6s. worth of fertiliser is applied to one acre of ground in a year.

Benares Pharmaccutical Trade.

In a report which the American Consul sends to Washington regarding trade conditions at Benares, reference is made to the trade in pharmaceutical products, and the good demand for medicine generally. It is stated that there are fourteen hospitals in Benares. On account of the great

prevalence of illness of various sorts among the incoming pilgrims and among other residents, there is a large trade in medicines. On inspection of several of the numerous native drug stores in Benares, many American patent medicines were noticed, as well as preparations made in England and Germany. Homœopathic medicines seemed especially popular. The native doctors apparently have no hesitation in prescribing foreign medical preparations, together with their own native remedies—some of which have undoubted value. The business in patent medicines at Benares is carried on chiefly through large distributing houses in Calcutta. The small retail shops are usually obliged to accept strictly cash terms in making purchases of new stock.

Camphor from Formosa.

In a series of trade notes covering the industries of Formosa, sent to the Commerce Department by the United States Consul Williamson, the statement is made that the total exports of camphor from Formosa from April to December, 1913, are expected to reach the equivalent of 6,000,000 lbs. It is also stated that "a trial shipment" of powder camphor, under the name of "hana-shono" or flower-camphor, met with great success in India, and a sudden increase in demand is looked for.

Curacao Phosphate Mining.

According to a report from Curacao to the Commerce Department in Washington, the work in the Curacao phosphate mines, which has been suspended for nearly twenty years, has now been resumed. It is stated that one cargo has been shipped and two more vessels are loading. The phosphate is said to be of excellent grade, and formerly was shipped in large quantities. It is now going to England and Germany. The company engaged in the mining operation is English, and was organised for phosphate operations in the Dutch West Indies.

Important Salt Concession in Venezuela.

A concession for the operation of the Venezuelan salt beds for two years from January 1st, 1914, has been awarded on December 29th, 1913, to the Compania Anonima de Navegacion Fluvial y Costanera de Venezuela, for 8,000,000 bolivars.

MARKET REPORTS.

LONDON.—There is no improvement of the general trade in chemicals to report, the markets having remained rather slack during the period under review. The exports for the last month do not compare favourably with those of February, 1913, the total value amounting to £1,745,967, against £1,846,517 in the corresponding month of last year. The decrease was fairly general in the section for heavy chemicals. Bleaching powder showed a diminution of 18,520 cwts., which is chiefly due to the poor offtake for American account. An important decline occurred in copper sulphate, sulphuric acid, dyestuffs, and miscellaneous chemicals, while coal products (not dyes), show an increase of £24,000. Though the values of the exports of soda compounds were slightly lower than during the same month of last year, the quantity has increased by 11,300 cwts. to 480,739 cwts. The home trade has been unfavourably affected by the uncertain political situation, which caused a feeling of distrust among a section of the business world, and thus proved a deterrent to the hoped-for revival of trade. It appears doubtful whether this

deleterious factor will soon be removed, however much this may be desired by the general business world, and it is, therefore, safer to reckon with a continuance of the present conditions than to count on a sudden change for the better.

Although the season of increased consumption in chemical fertilisers is drawing very near, the market has not shown any improvement as far as prices are concerned. It is true that the demand for sulphate of ammonia has slightly improved, but not sufficiently to balance the large production in Great Britain, on the Continent, and in the United States. The position causes some anxiety to the producers, though the majority are still fairly confident about the future, as they think it possible that the trouble threatening in the Yorkshire coal trade may benefit prices. The present quotation for gray 25% sulphate of ammonia, prompt, is £11 12s. 6d.—£12. The market for nitrate is fairly steady, although the buyers are very reluctant to operate in view of the weak statistical position of the article. The Continental stocks are very considerable, and they keep growing, which seems to justify the cautious attitude of the consumers. Ordinary quality is obtainable at £10 15s. per ton, and refined at £11 5s. Tar products are characterised by a general slackness and drooping prices, with the exception of creosote, which maintains a very firm tendency. A further hardening of prices may be expected if the present demand continues. Ordinary quality is firmly held at 3½d. per gallon naked at works. Pitch proves a very disappointing article to the producers, for though there are no large stocks and the time for increased demand is approaching, the tone is very dull. The maker's price is 38s.—39s. 6d. per ton at works. If the threatened strike of the Yorkshire coal miners should break out, a rise must immediately be expected; but even if a settlement of the dispute take place, the present low quotations may induce more business in the near future. Benzols are rather quiet, as neither the home consumers nor the Continental importers show any strong inclination to buy. Five per cent. benzol, prompt, is quoted at 11½d.—1s., and 90% quality at 1s. 1d. per gallon. Naphthalene continues in good demand with moderate supplies. Very little interest is shown for naphtha, the prices of which tend downward. Carbolic acid remains quite neglected. Crude 60% prompt is quoted nominally at 1s. 0½d.—1s. 1d. per gallon.

MANCHESTER.—In consequence of the depression in the cotton industry of Lancashire the trade in chemicals is very unsatisfactory, and there is little ground for expecting a speedy improvement. The general tendency of prices is fairly steady, though some materials favour buyers. Acetate of lime develops pronounced weakness; this can hardly surprise if one considers the high prices which have been obtained for some time. Brown acetate of lime is freely offered at £5 15s., and grey at £8, or a little lower. Caustic soda is quoted at £8 12s. 6d.—£10 12s. 6d., according to strength. Powdered arsenic remains steady at £14. Some other leading products are quoted as follows: borax, crystals, at £17 10s., bleaching powder at £5 7s. 6d. for soft wood, and £5 17s. 6d. for hard wood, carbonate of ammonia at 3½d., potash, 90—92%, at £15 10s., chlorate of potash at 3½d., cyanide of soda at 8d., prussiate of potash at 5½d., and sulphate of copper at £21 15s., for prompt and near delivery.

LIVERPOOL.—The chemical trade is confined within very narrow limits. Sulphate of copper has further receded in the absence of demand. Shipments in February were

7,464 tons, against 9,739 tons last year, and 13,944 tons in February, 1912. Cream of tartar remains steady. Tartaric acid is slightly firmer. Bleaching powder is slackier than for some time. An interesting event was the recent opening of the new clearing house for the oil, seed and produce trade. It is stated that it will, for a time, be used for dealings in linseed oil and cotton-seed oil futures, but an extension of its scope may confidently be expected at an early date.

GLASGOW.—The forward inquiry for heavy chemicals is not up to expectation, but the deliveries on current contracts are rather better. Alkali produce remains steady. Ammonia alkali is scarce and in better demand. Bichromates of potash and soda remain very quiet and a weakening of prices is considered likely. Lead products develop firmness.

Metal Markets.

LONDON.—The copper market has taken a turn for the better, and the pronounced pessimism that ruled for some time has yielded to a more hopeful view of the future. The fairly good result of the European statistics removed the fear of another increase of stocks. The speculative interest has again revived, although trade conditions are still very unsatisfactory and the political situation at home and abroad does not tend to bring about a speedy improvement. There has been a fair amount of inquiry on home and Continental account, causing the quotation for electrolytic to rise to £67 per ton. Cheap parcels of this metal are no longer offered. Standard copper closes at £63 18s. 9d. cash, and £64 7s. 6d. three months. The tendency in the tin market has improved and the sellers have been less eager to get rid of their goods, as the statistical position seems to favour better prices. This month's shipments are expected to be small, while the deliveries on American account promise to be larger. On the other hand, it ought to be remembered that the market has a large excess of supplies to digest compared with last year. The closing quotation for cash tin was £172 17s. 6d., and the settlement price was £173. The poor demand for Welsh tinplate and an accumulation of stocks in Wales acted very unfavourably on the prices. The outlook is the reverse from cheerful. Lead maintains a firm attitude. A good deal of contract lead is still to be covered, and the stocks in consumer's hands are very moderate, so that firm prices appear probable. Spelter remains unsatisfactory but the syndicate made no change in their quotation which remains at £21 17s. 6d.

CONTINENTAL FINANCIAL ITEMS.

Verein. chemischè Fabriken in Mannheim made a gross profit for the year of 2,524,274 marks (2,739,052). After writing off 658,471 marks (589,196), the net profit amounted to 1,456,544 marks (1,761,079), to which must be added 520,000 marks brought forward from last year. The dividend will be 20% (same as last year). The directors state that the general conditions during the last year were unfavourable, and the higher costs of raw materials have diminished the profits. It has not been possible to counteract this effect by increased sales.

The A.-G. Vereinigte Chem. Fabriken (S. T. Morosow, Krell, Ottmann), Berlin, made a net profit of 131,752 marks (76,617), and will pay 6% (5%) carrying forward 9,038 marks.

The "Oesterreichische Verein fuer chemische und metallurgische Produktion" at Aussig have amalgamated

with "Hungaria," a company manufacturing chemical fertilisers and sulphuric acid, with works at Budapesth. Financial assistance has been given by the Anglo-Austrian Bank and the firm of Adolf Kohners Soehne. The Aussig concern takes over most of the shares of the "Hungaria" and increases the capital by 2,500,000 kr. to 14,500,000 kr. Both companies will be under the management of Josef Benes, general manager of "Hungaria," the head office to be at Vienna.

Gelsenkirchen-Schalke.—The Aktien Gesellschaft fuer chemische Industrie intend to increase their capital, which at present amounts to 2,500,000 marks. The dividend for 1913 is estimated at 10%.

Duisburg.—Chemische Fabrik "Glueckauf" G.m.b.H. has been registered at Oberhausen. The object of the new company is to manufacture chemicals and apparatus for laboratory use. Capital, 20,000 marks. Manager, Dr. Otto Weingarten, chemical engineer of Duisburg.

Hamburg.—A new company with a capital of 1,200,000 marks has been registered at Hamburg under the style of Hanseatische Teer-Produkten-Fabrik Holtermann & Co. G.m.b.H. The object of the undertaking is the manufacture of tar products.

Chemische Fabrik H. Weitz G.m.b.H. in Berlin will take over the manufacturing business of H. Weitz, the latter to be general manager. The capital of the new company amounts to 130,000 marks.

Melanolwerke G.m.b.H. at Freiburg, is the title of a new company, the object of which is to manufacture melanol and other chemical products. Capital, 20,000 marks.

Vienna.—"Kliva" G.m.b.H. Fabrikation chemischer Produkte. Capital, 30,000 kr. Object: To manufacture chemicals.

Martinswerk G.m.b.H. fuer chemische und metallurgische Produktion, has been registered at Bergheim. Object: To manufacture chemical and metallurgical products of all kinds. Capital, 100,000 marks.

Chemische Fabrik Huxaria G.m.b.H. at Hannover. This new company has been promoted for the purpose of manufacturing chemical, pharmaceutical, and bacteriological products. Capital, 20,000 marks.

"Ciba" Chemische Industrie, G.m.b.H. will deal in chemical products, especially "Ciba" Brand articles. Capital, 400,000 kr., fully paid. Registered address: Westbahnstr. 27, Vienna VII.

P. Beiersdorf & Co. G.m.b.H. has been registered in Vienna. Capital, 20,000 kr., fully paid. Object: To manufacture pharmaceutical and cosmetic preparations.

AMERICAN FINANCE.

Yellow Cross Corporation, Manhattan. Capital, \$50,000. Object: To manufacture and deal in chemical and hygienic articles. Incorporators: J. B. Smith, jun.; J. F. McDavitt, New York City.

The American Tar Products Co., Wilmington, under the laws of Delaware. Capital, \$5,000,000.

Springfield Chemical Products Co., Springfield, Mass. Capital, \$25,000.

The Camphor Importing and Manufacturing Co., Jersey City. Capital, \$200,000. Incorporators: G. A. Anderson, Brooklyn, N. Y.; E. A. Buck, Arlington; A. Dinkelspiel, East Orange.

Franco-American Chemical Co., New York City. Capital, \$10,000. Incorporators: F. J. Byrne, J. B. Wentworth, P. C. Petit.

The U. S. Industrial Alcohol Co. has issued its report for the year ended December 31st, 1913. According to this report the gross profits from all sources amounted to \$1,006,774, against \$1,437,522 in 1912, and \$1,308,399 in 1911. The net profits were only \$652,358, compared with \$1,021,751 and \$902,745 during the two previous years.

The directors of the National Carbon Co. have declared a dividend of 50% on their common stock.

The General Chemical Co. reports to the New York Stock Exchange a net profit of \$2,620,346 (for the eleven months ended November 30th, 1913).

Bore-Salicine Co., Incorporated, has been incorporated in order to manufacture drugs and chemical preparations Capital, \$1,500,000.

Burmack Manufacturing Co., in New Jersey. Capital, \$50,000. Object: To manufacture chemicals, etc.

NEW COMPANIES.

A. T. P. SYNDICATE, LTD.—Capital, £5,000 in £1 shares. Object: To carry on the business of chemists, druggists, dry-salters, manufacturers of, and dealers in, proprietary articles, etc.

MACKNIGHTS, LTD.—Capital, £10,000 in £1 shares (1,000 first preference, 1,000 second preference, and 8,000 ordinary). Object: To take over the business of chemical manufacturers and workers, carried on at Frodsham Bridge, Cheshire, as MacKnight and Jack, and to adopt an agreement with A. MacKnight and J. S. MacKnight. Registered office: 51, North John Street, Liverpool.

LASSALLES, LTD.—Capital, £2,000 in £1 shares. Object: To take over the business carried on by Dr. Fritz Lassalles at 9, Blenheim Street, W., and to carry on the business of manufacturers of, and dealers in, toilet specialities, chemicals drugs, perfumes, oils, etc.

T. H. PRATT & CO., LTD.—Capital, £2,000 in £1 shares. Object: To take over the business carried on at 154, Bartholomew Street, Newbury, by T. H. Pratt, to carry on the business of operative, manufacturing, analytical and dispensing chemists, or druggists, etc.

REEFS SYNDICATE, LTD.—Capital, £2,000. To carry on in Turkey, the Turkish Dominions, Egypt, or elsewhere, the business of winners and workers of natural gas, bitumen asphalt, ozokerit and other mineral products, etc.

PNEUMOSAN CHEMISCHE FABRIK, LTD.—Capital, £3,000 in 10/- shares. Object: to carry on the business of chemists, druggists, dry-salters, etc., and to adopt an agreement with A. Newton. Registered office: 132, Great Portland Street, W.

FINANCIAL ENGINEERING AND CHEMICAL CO., LTD.—Capital, £8,400. Object: To acquire the assets of the Electrolytic Alkali Co., Ltd., in liquidation, or some of them, or an option thereon, to promote a company for repurchasing such assets, and to carry on the business of manufacturers of, and dealers in, bleaching powder, soda, salt, brine, and residual products, electrical and general engineers, etc. Registered office: 62, London Wall, E.C.

PYRENE Co., LTD.—Capital, £5,000. Object: To carry on the business of manufacturers of, and dealers in, Pyrene and other fire extinguishers and apparatus, chemical

and electrical compounds, etc., and to adopt an agreement with the Pyrene Manufacturing Co., of the State of New York. Registered office: 29A, Charing Cross Road, W.C.

MARYPORT MOTOR BENZOLE CO., LTD.—Capital, £10,000 in £1 shares. Object: To carry on at Maryport, Cumberland, and elsewhere the business of refiners and distillers of benzole, manufacturers of chemicals and the products thereof, etc., and to adopt agreements (1) with the Saint Helens Colliery and Brickworks Co., Ltd., the Flimby and Broughton Moor Coal and Fire Bricks Co., Ltd., and the Oughterside Coal Co., Ltd., and (2) with W. Irwin.

H. COGHILL & CO., LTD.—Capital, £30,000 in £1 shares. Object: To take over the business carried on at Liverpool and Newcastle-under-Lyne as H. Coghill and Son, to carry on the business of manufacturers of borax and boracic acid, salt and alkali, dealers, etc., and to adopt an agreement with J. C. Bladen.

SHARE LIST.

Name of Company.	March 24th.	February 24th.
Alby United Carbide	11 ¹ / ₆	13 ² / ₃
Ditto. Pref.	1 ¹ / ₂	1 ¹ / ₂
Associated Portland Cement. (10)	51 ³ / ₆	6 ¹ / ₆
Ditto. Pref. (10)	8 ¹ / ₆	8 ¹ / ₆
Babcock-Wilcox. Ord. ..	3 ³ / ₆	3 ³ / ₆
Ditto. Pref.	1 ⁵ / ₆	1 ⁵ / ₆
Bell's United Asbestos	1 ¹ / ₆	1 ¹ / ₆
Belachers' Association. Ord. ..	1 ¹ / ₆	1 ¹ / ₆
Ditto. Pref.	1 ¹ / ₆	1 ¹ / ₆
Borax Consolidated. Pfd. (5) ..	51 ¹ / ₆	51 ¹ / ₆
Ditto. Defd.	1 ¹ / ₆	1 ¹ / ₆
Ditto. Pref. (10)	11 ¹ / ₆	11 ¹ / ₆
Bradford Dyers	1 ¹ / ₆	1 ¹ / ₆
Ditto. Pref.	1 ¹ / ₆	1 ¹ / ₆
British Oil and Cake. Ord. ..	1 ¹ / ₆	1 ¹ / ₆
Brunner Mond. Ord.	4 ¹ / ₆	4 ¹ / ₆
Ditto. 7% Pref. (10)	14 ¹ / ₆	14 ¹ / ₆
Bryant and May. Pref.	2 ¹ / ₆	2 ¹ / ₆
Calico Printers	1 ¹ / ₆	1 ¹ / ₆
Ditto. Pref.	1 ¹ / ₆	1 ¹ / ₆
Castner Kellner	2 ¹ / ₆	2 ¹ / ₆
Commercial Salt. (2/-)	8/-	8/-
Crossley & Sons. (2)	11 ¹ / ₆	11 ¹ / ₆
Ditto. 5% Pref.	4 ¹ / ₆	4 ¹ / ₆
Eastman Kodak. (\$100)	500	550x.
Eley Brothers	1 ¹ / ₆	1 ¹ / ₆
Fraser and Chalmers. (£3) ..	1 ¹ / ₆	1 ¹ / ₆
Gas Light and Coke. (S.) ..	100	102
Ditto. 4% Pref. (S)	95	98
Greenwich Lino. (½)	2 ¹ / ₆	2 ¹ / ₆
Harrison and Crossfield. Pref. ..	1 ¹ / ₆	1 ¹ / ₆
Imperial Continental. (S) ..	172	177
Ditto. 3½% Debenture (S) ..	83 ¹ / ₆	85 ¹ / ₆
India Rubber Co. (10)	10 ¹ / ₆	11 ¹ / ₆
International Salt	3/6	4/6
Ditto. Pref. (5/6 pd.)	1 ¹ / ₆	1 ¹ / ₆
Lever Brothers. 1st Pref. (10) ..	11 ¹ / ₆	11 ¹ / ₆
Lister & Co. Ord.	1 ¹ / ₆	1 ¹ / ₆
Mappin & Webb. Ord.	1 ¹ / ₆	1 ¹ / ₆
Neuch'tel' Asphalt.	9 ¹ / ₆	10
Nobel Dynamite. (10)	17	17 ¹ / ₆
Ditto. Bearer (10)	17 ¹ / ₆	17 ¹ / ₆
Ditto. 5% Pref. (10)	11	12
Pears, A. and F. Ord.	12 ¹ / ₆	12 ¹ / ₆
Ditto. 6% Pref. (10)	12 ¹ / ₆	12 ¹ / ₆
Price's Candle. (16)	36 ¹ / ₆	38 ¹ / ₆
Rosario (5)	9	9 ¹ / ₆
Salt Union. (4)	1 ¹ / ₆	1 ¹ / ₆
South Metropolitan 4% Standard (S)	109 ¹ / ₆	111 ¹ / ₆
Ditto. 3% Debenture (S)	73	75
United Alkali. (10)	6 ¹ / ₆	7 ¹ / ₆
Ditto. Pref. (10)	1 ¹ / ₆	1 ¹ / ₆
Val de Travers	1 ¹ / ₆	1 ¹ / ₆

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
" " Abroad 8s. " "

It is almost impossible to convey an adequate

impression of the increase of activity in scientific matters in America. The Bureau of Mines, which issues records of experimental work, to which we have repeatedly called attention, has spent some £70,000 on research during the last year.

Twenty-five years ago the number of works employing chemists in the States was very small, and then the work was almost entirely connected with routine work. All this is changing. "It is claimed that research has now established itself among the foundation stones of our industrial system, and the question no longer is, What will become of the chemists? It is now, What will become of the manufacturers without them?"

There are now at least fifty laboratories connected with industrial research in special industries. The expenditure of several of these exceeds £60,000 per annum. The United States Steel Corporation has not hesitated to spend this amount on a single research.

In dealing with the research laboratories it is held that these should be developed around a special library, the business of which should be to collect, compile, and classify, in a way to make instantly available, every scrap of information bearing upon the materials, products, and requirements of the industry concerned.

The present position of research is summed up in the following sentences: "Industrial research is applied idealism. It expects rebuffs, and it learns from every stumble, and turns the stumbling-block into a stepping-stone. It knows it must pay its way. It contends that theory must spring from practice."

It is possible that, before long, the English manufacturer may be watching a first-class duel between the leading German and American manufacturers, the result of which will depend upon certain factors which will be greatly influenced by the work of chemists.

English Results.

It is not often that any English firm publishes particulars of this nature, but we have recently had an insight into the profits obtained by one firm which has for some years adopted a scientific control, for this is stated in direct figures in the recent address of the President of the Institute of Chemistry (Professor Meldola). In sending a substantial subscription to the Institute of Chemistry Building Fund, the manager of the Colonial Sugar Refining Co. writes as follows:—

"It may interest you to know that each of our factories has its laboratory and staff of analysts, and that their check on the work costs some £20,000 a year. This system and staff we have been building up for the last thirty years, with a very manifest effect on the earning power of the business; indeed, since 1900 the reduction in wastes has amounted to between £75,000—£100,000 a year and following on very large savings effected between 1883 and 1900.

"From these figures you will see that we may reasonably be expected to take an interest in the progress of the Institute, and generally, in the application of science to processes of manufacture."

We have here an English company, working on so every-day a product as sugar, spending £20,000 per annum on its chemical laboratories, and finding, as a consequence, that they reap a harvest, in hard cash, of £75,000—£100,000 per annum over the transaction.

It is difficult to state the results in ordinary business terms, as the greater part of the £20,000 expended is obviously not on capital account. It is not unreasonable to assume that this firm finds its laboratories a 500%—1,000% investment. It may also be reasonably asked what other department could show such results on an equal unit of capital?

Nomenclature.

It will be remembered that the late Professor Huxley took great exception to the use of the term "scientist." Of recent years there has been a tendency to introduce into general language certain terms which may equally be regarded as objectionable. Thus Professor V. Boys in a recent issue of *Nature* takes exception to the use of the term kinematographer.

The expert in his laboratory coins systems, which somehow the average man cannot approach without feelings of resentment. Take, for example, the case of that queen of science which deals with the vegetable world. It is not too much to say, that the science of botany has been "snowed under," so far as the general public is concerned, by a system of classification which can only be followed by one who has had a general training in science, and its methods.

Thus, many have turned away to the more lively regions of romance, or contented themselves with the general writing of authors like Maeterlink. Is this a necessary and essential condition to the advancement of science? The effect on the public is obvious. Interest in subjects of extreme importance is practically non-existent. The artistic temperament in particular revolts against what it considers the sacrilegious treatment of subjects which should, under more reasonable conditions, be the birthright of all.

There is something to be said in this direction, if, by any means, this difficulty can be lessened, and science set down in terms which can appeal to the conscience of the average man.

That the task is a difficult one is beyond all question, but there is no evidence that it is impossible of achievement.

To begin with, the coining of words which may in the course of events enter the ordinary currency should receive special attention, if not supervision. Thus, to the writer, the word "researcher" is a horrible one. Rightly, or wrongly, it will not be used in this journal until it has received the seal of some recognised authority. Yet it is rapidly finding a place in everyday life, and has apparently received the approbation of the Fabian Society. It may well be ranked with "movies," which has, we believe, received acceptance in certain high quarters as an expression to describe the effect produced in kinematography.

CRUCIBLE ⁷¹. ELECTRIC FURNACES.

By C. T. NESBITT, A.R.S.M.

THERE is no doubt that England is behind the times in the matter of electric furnaces for iron and steel production, and this is all the more remarkable when one considers the cheap cost of power in many parts of the country. It is a well-established fact that "crucible" steel, for example, can be made cheaper, of more uniform quality, and in immensely larger quantities in the electric furnace than in pots, yet very few of the pot or crucible furnaces of Sheffield—the home of the crucible steel maker—have been discarded for the modern electric ones. Indeed, the electric furnaces in Sheffield are probably about half a dozen all told, and are practically all in the hands of the larger firms. The cause of this is no doubt partly because power is expensive there, '66 pence per kilowatt hour being about the figure; but within a very few miles it can be obtained at the low price of '2 pence per kilowatt hour. At this figure the very best crucible steel could be put on the market at Sheffield to undersell that produced in crucibles, and still pay a good 10% profit on capital and production costs.

There are two main factors which have so far prevented this being done. The first is that the crucible furnace product is practically all in the hands of a number of small firms, most of which have been in existence for generations. They, with the natural conservatism of Englishmen, and possibly also want of sufficient capital, have set their faces against any change, and have endeavoured to keep the whole of the crucible steel market in their own hands—as it has been for the last 150 years. The second is that the steel produced in the first few electric furnaces, though being of excellent quality as regards chemical composition, and quite equal to the best crucible steel in that respect, was produced by men more familiar with the electrical and engineering side of the business than of producing steel as a marketable commodity. The consequence was bad ingots were made, they were piped or had much segregation, and when rolled down to billet or bars, these bars were unsound, rokey, and essentially unfit for the many delicate instruments and other purposes to which crucible steel is put. Thus consumers began to regard electric steel as nowhere near so good as the crucible made product, and it is only in the last few years that this idea is gradually being done away with by the excellent quality and rolling properties of electric steel when properly produced.

With regard to the cost of the two processes, taking power at Sheffield, for example, at '66 pence per kilowatt hour, steel can be produced in almost any of the later type of furnaces (Girod, Heroult, Roechling-Rodenhauser, etc.) at £2 10s. per ton melting costs. Crucible melted steel varies from £2 10s. to £3 per ton in fuel-fired pot furnaces, depending on the market price of fuel. Gas-fired

crucible furnaces are not favoured and seem to be dying out gradually, so will not be considered. Thus the two processes compared for melting costs give some slight advantage to the electric furnace, even with power at '66 pence per kilowatt hour. In many parts of England power can be obtained at '3 and '25 pence per kilowatt hour, and in isolated cases it has been offered at '18 pence for a large consumption. Taking these latter power figures into consideration, melting costs are largely in favour of the electric furnaces, but of course against this cheaper power the extra freightage to Sheffield (where practically all crucible steel is marketed) would have to be reckoned.

Now for output. Electric furnaces of various sizes up to 12½ tons capacity have been in use on the Continent for some years. There is a 15-ton Heroult furnace at work quite satisfactorily in the U.S.A. The usual size, however, is from 5 to 8 tons; reckoning 6 tons as a fair average, the output from one of these, tapping every eight hours (a very liberal estimate; many firms get out a heat in under six hours) would be 18 tons. Now an average pot furnace has a dozen holes, and each hole contains two pots, so that 3 tons would be got out in twelve hours, reckoning 1¼ cwt. per pot and three heats in that time, a fairly liberal estimate. These pot furnaces are rarely run on double shift. This gives three times the output to the electric furnace, and, of course, could be increased to six or eight times. Where the latter furnace has an immense advantage, however, is in the raw material used. The very commonest scrap or pig iron can be used and converted into material equal to the best crucible made product, while crucible steel can only be produced from the best blister steel or Swedish iron at more than twice the cost for raw material. The convenience of the electric furnace is well exemplified here—any desired carbon contents can be obtained in the finished steel with certainty and without trouble, but in the crucible process the blister has to be carefully selected with regard to "temper" (carbon percentage), or Swedish iron "let down" with milder scrap, so as to obtain a final product of the desired composition. Mild steel with addition of charcoal is sometimes used, but does not give such good results.

The relative cost of plant is so dependent on local circumstances; on whether generators or transformers would have to be used in connection with existing power supply; on whether coke or gas-fired pot furnaces were to be used, etc., etc., that it is impossible to consider the matter with any degree of accuracy on a general basis. It may be said that, though the cost of a complete electric furnace plant with generator and power supply would much exceed that of a crucible furnace or even a battery of three

or four furnaces, yet the larger output of the former would more than balance this from a financial standpoint.

From a purely scientific point of view the advantage is all on the side of the electric furnace, more especially so when induction furnaces are considered. In pot furnaces a perfectly "dead" melt can be obtained, but the influence of the crucible itself on the product must be something, if only slight. Steel in the electric furnace in contact with the refractory hearth is very much less, volume for volume, than in crucibles. Again, the lining of electric furnaces is usually basic—magnesite or dolomite, and molten steel has notably less action on this than on the acid or graphitic materials of which crucibles are composed.

In both processes the atmosphere to which the steel is subjected is reducing, that is, it is reducing in arc, but may be neutral or reducing in induction furnaces. In crucibles the products of combustion must come into contact to some extent with the steel and tend towards contamination; no silica or graphitic pots, however carefully made, are absolutely impermeable to gases.

The waste products of electrode consumption are probably less harmful than those of coke or slack (except in the case of sulphur), as they are made from carefully selected and washed materials.

The writer has examined and analysed a number of electrodes from various sources, but has not found any with less than 1.5 % sulphur. The slags of an arc electric furnace are always heavily basic; the pure limey finishing slag being allowed to take up carbon from the electrodes, the calcium carbide so formed eliminates the sulphur in the metal and prevents

ingress of any from the arcs, so this possible source of contamination is guarded against. Of course in an induction furnace there are no sources of contamination from the heating arrangement. An efficient proof of this is given by analysis; steel from either arc or induction furnaces made from common and cheap scrap, can be easily manufactured containing only the merest trace of sulphur—certainly under .005 %. Best crucible steel rarely shows less than .010 % sulphur even when made from first-class blister steel or Swedish iron.

The labour costs of the two processes are much the same, about four or five men being required in each case.

The scope of this article does not warrant many details of the electric furnace as used for other than special or crucible steels. It may be mentioned, however, that in the U.S.A. several electric furnaces are producing rail steel, are getting another 10s. per ton for their product above the ordinary market price, and are doing well from a financial point of view. This shows that the electric furnace is not restricted to the very best class steel where power can be obtained moderately cheaply.

Statistics at the end of last year show that there were only ten electric furnaces actually engaged in steel manufacture in England, and three or four more were in process of construction. On the Continent (chiefly in Germany and France) there were over 100, while in the U.S.A. the number was about twenty. What a very poor show England makes in comparison with our Continental neighbours—England which used to be a long way ahead of any other nation in the latest improvements for the manufacture of iron and steel.

A METHOD OF OBTAINING A MEASURE OF THE COLOUR OF METALS AND ALLOYS.

By FRANK CHARLES THOMPSON (University of Sheffield) and ERIC SINKINSON (Imperial College of Science and Technology).

PART I.—INTRODUCTION.

THE colours of the non-ferrous metals, well known as they often are (thus, coppery, brassy or golden), have so far lacked methods of actual measurement.

The subject, however, is one of considerable practical importance, especially, perhaps, in the case of the German silvers. Many points of theoretical interest would no doubt also arise if the relationships of metallic colour to chemical composition and microscopic structure could be determined. The method of measurement to be described in this paper is only a partial solution of the problem, in that it is sensitive only to variations of colour sufficiently great to be distinguished by the eye. It possesses, however, the advantages that no great expenditure or manipulative skill is required, whilst allowing a numerical expression to be given for the intensity of a metallic colour.

It had been hoped to obtain results of measurements depending on the following application of polarised light:—

A beam of plane polarised white light is thrown by a vertical reflector on to the polished surface of the metal from a Nicol prism which may be rotated in a graduated mount. After reflection the light passes through a quartz plate and is viewed through an analyser. For a certain position of the polarising Nicol the "sensitive tint" is obtained, *i.e.*, the very rapid transition from red to blue. It seemed likely that the wave lengths absorbed by the metal (the determining factor in the coloration) should cause an alteration in the polariser reading for the sensitive tint, whence a measure of the colour might be obtained depending on the actual vibrations absorbed.

Such hope, however, has proved illusory. Even when the determination of the sensitive tint has been rendered more delicate and easy by the aid of a

bi-quartz plate, (in which one half rotates the plane of polarisation to the left whilst the other rotates it to the right), no change of reading could be detected, even when such a typically red metal as copper is substituted for such a white one as silver. Further investigations, however, by one of the authors are proceeding in this direction.

The process which forms the real subject of this paper is in brief the photography of the metallic surface under constant conditions of exposure and development, and the determination of the density of the resulting negative.

The whiter the metal the greater will the density be, and the ratio of the density of the negative for standard silver to that for the metal under investigation may be taken as the colour figure for the metal. The densities were compared in a Sanger-Shepherd densometer and, if the silver negative has a density of 11 on the scale and the metal one of 9.5, the ratio 1.22 expresses the degree of colour of the metal, or, disregarding decimal places, the intensity of colour may be taken as 22. Since determinations by different investigators would vary slightly for the same metal, it is proposed to take standard silver and pure copper as the standards at 0 and 50, and re-calculate to these values the ratios for the other metals.

PART II.—EXPERIMENTAL.

It is of the greatest importance that every essential condition should be maintained rigidly constant. Even the *smallest* variation from the standard conditions results in hopelessly erratic determinations. Thus, in spite of the fact that

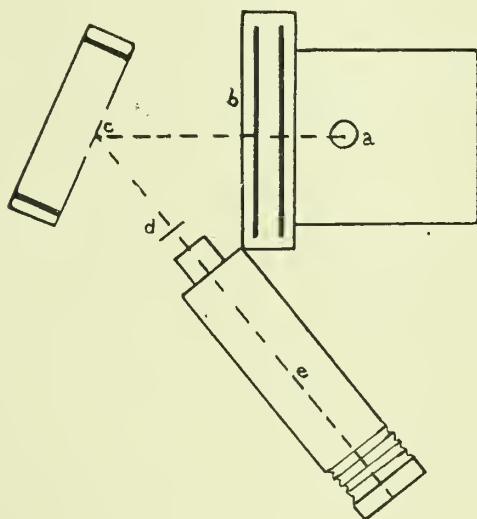


FIG. 1.

throughout the work the greatest precautions were taken to ensure rigid adherence to the conditions to be laid down, the reference sample of standard silver was photographed alongside of the metal on each plate. Thus any *small* fluctuations of illumination or of development, affecting silver and metal almost alike, produce an inappreciable alteration on the density ratio.

The apparatus consists of :—

(a) A carefully aged Welsbach burner, provided with a gas pressure regulator, as the standard source of white light. This is placed inside a metal case to minimise the general illumination, whilst for the same reason the exposures are carried out in a darkened room.

The light from an aperture 2 ins. square in the case falls after passing through (b) a diffuser on the metal samples held in a stand (c).

The diffuser consists of two large ground-glass plates placed 1 in. apart and mounted in a frame, just in front of the metal case. This means of securing perfect uniformity of illumination was found very satisfactory, and all parts of the negatives of a metal were of exactly the same intensity. The light after reflection passes through a colour screen (d) and ultimately forms an image of the metals on a photographic plate in a long camera box (e).

Fig. 1 shows diagrammatically the arrangement of the parts, all of which were screwed firmly to the bench. The light was incident on the metals at an angle of 30 degs., and to ensure the different metals occupying invariably the same position the following device was adopted (Fig. 2) :—

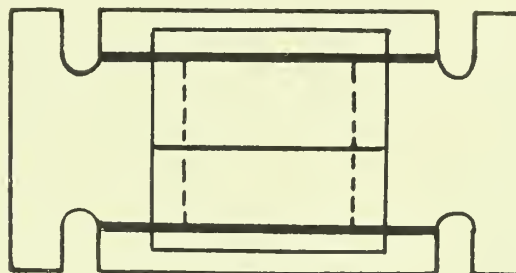


FIG. 2.

A brass plate 2 ins. by 1 in. with a hole $\frac{5}{8}$ in. square in the centre was obtained, and the specimens mounted behind this with the polished faces pressed by two rubber bands against the plate. This plate was then fixed in a rebate in the vertical wooden stand (c) with clips (Fig. 3). Thus the relative position of all the metals when photographed was exactly the same.

The camera, which is 20 ins. in length, was placed 7 ins. from the metals, and magnifies the image 3 diameters. A small length of bellows allow of an adjustment of the focus, which was arranged to give a slight diffusion in the image and prevent the formation on the negative of marks of the scratches on the surface of the specimen. These dimensions gave with the fixed conditions of exposure and development mentioned later a negative for silver, of density 10, which should be maintained constant in all comparison work.

The surfaces were prepared as for micro-sections, but without polishing. It was thought that the well-known alteration of the surface layer by polishing might possibly introduce errors, for which reason the specimens were photographed after very careful preparation ending by the rubbing on the "oooo" Fortin emery paper.

The actual photography necessitates the greatest care, in which the following points must all receive attention:—

(1) *Plate and Colour Screen.*—It was not found nearly so easy as had been expected to obtain a sufficient difference of density between, say, such metals as silver and copper. A very large variety of plates and colour screens were tried, including, for



FIG. 3.

the former, panchromatic, Ortho chromatic ordinary, fast and slow, and, for the screens, the Wratten and Wainwright K3, a Zeiss green screen and a blue. All these were tried in every combination, but the only successful result was obtained with the blue screen and an ordinary plate. The colour screen was simply a piece of ordinary blue glass, though a monochromatic filter, such as Wratten and Wainwright's Blue M, might conceivably yield a slightly better result. The plates used were Imperial Special Rapid (H and D 200), though many others would have done equally well. These plates and the blue

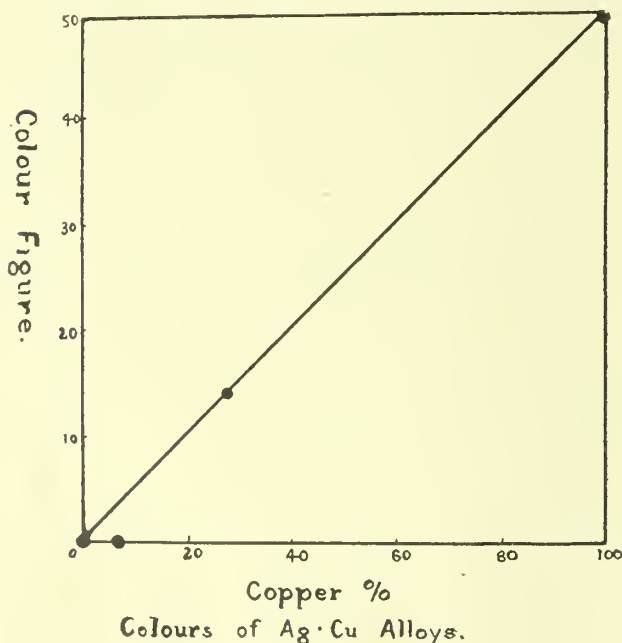


FIG. 4.

screen gave the best results of all the combinations tried.

(2) *Exposure and Development.*—As would be expected, however, the density ratio for any metal, even under constant conditions of light, plate and screen, varied very considerably with the length of exposure and conditions of development. Some preliminary experiments on these points gave the following results:—

(1) *With Constant Development.*

Time of exposure:—

In seconds	..	1	5	30
Ratio	..	1.66	1.24	1.11

(2) *With Constant Exposure.*

Time of development at 16° C.:—

In minutes	..	2	5	10
Ratio	..	1.24	1.40	1.53

The necessity for rigid consistency with the conditions of exposure and development thus becomes apparent.

Throughout the actual series the exposures were made for three seconds with the lens stopped to F 6, and an automatic shutter is essential to accurate duplication of results. The developer used was new Rodinol, very carefully diluted twenty times, and at a temperature of 16° C. The temperature of development has a considerable influence on the density of the resulting negative, and throughout the experiments was kept constant by keeping all liquids, and developing, in a thermostat at the temperature mentioned.

It was deemed advisable to test the sensitiveness of the densometer, and a certain ratio was determined independently by both of the authors with the following results:—

(1) 1, 1.829; (2) 1, 1.834, an agreement amply sufficient for the purpose of this research. It may be mentioned here that the density ratio of each negative was determined in duplicate. Another ratio was obtained to investigate the errors likely to arise through an imperfect preliminary setting of the meter.

		(True setting.	Much too high.	Much too low.
Ratio	..	1 1.44	1 1.43	1 1.45

The setting in each of the last two cases was far worse than any possible inaccuracy in ordinary use, so that errors due to this cause may be neglected.

Duplication of Results.—How far it is possible to duplicate results of a colour ratio under the fixed conditions is indicated by the following results of tests made on different dates and after re-rubbing on the "0000" paper:—

		1	2	3	Mean.
Ratio	..	1.20	1.22	1.21	1.21

Thus a ratio may probably be determined with an error of about .005 if duplicate exposures are made.

PART III.—RESULTS.

The method described has yielded the following results:—

Material.	Composition.	Density ratio compared with Ag.	Colour Figure Ag = 0 Cu = 50.
Standard silver	Ag 92.5 Cu 7.5	Standard = 1	0
Pure silver	Ag	1.00	0
	Cu Ni Zn		
German silver I.	55 15 30	1.02	5
German silver II.	57 7 36	1.04	10
"Eutectic Ag Cu"	70 Ag 30 Cu	1.06	14
Aluminium bronze	Cu 88 Al 12	1.09	22
Brass	Cu 99.8 Sn 0.2	1.11	26
Bronze	Cu 91.7 Sn 8.3	1.21	50
Kahlbaum copper	Cu	1.21	50
Swedish bar iron	Fe 99.8	1.02	5

Not quite of the eutectic composition.

It will be seen from the results given that an increase of coloration in the metal does give a higher "colour figure." The method can detect no difference between pure and standard silver, and is only just sufficiently sensitive to distinguish between the limits of the German silvers, and so is probably unfortunately inapplicable to this branch of alloys. The Swedish bar iron was inserted to find out how far the results were actual measures of the colours.

As will be seen, the slightly greyish white of the iron gives a result which deviates slightly from that for silver. The result is of considerable interest as showing, when compared with the work of Hagen and Rubens on the reflecting power of metals, that the photographic method does yield a true measure of the colour and not merely of the reflecting power, since those workers found very different powers for silver steel, far more widely divergent than the ratio here obtained. The figures for silver, copper and the silver-copper alloys are of interest in that they tend to show, as would be expected, that in what is almost a simple eutectic series the colour is a linear function of the composition (Fig. 4).

In concluding, the authors would wish again to emphasise the great care necessary in determining the colour of a metal by this process of photography, but to affirm their belief that with this implicit care a real measure of the colour of a metal may be obtained.

NOTES OF MEETINGS.

Royal Society.

May 13th. Annual Soiree.

Chemical Society.

May 7th and 31st.

Society of Chemical Industry.

LONDON SECTION.—May 4th.

Society of Public Analysts.

May 6th. G. D. Lander and J. J. Geake "The Detection of Castor Oil Seeds." H. Droop Richmond, "The Composition of Milk." J. F. Liverseege and G. D. Elsdon, B.Sc., "Note on 'Sharps.'" A simple form of Fat Extractor will be shown by G. A. Stokes.

Society of Arts.

May 4th. Recent Developments in Ceramic Industry (Lecture II.).

May 11th. Recent Developments in Ceramic Industry (Lecture III.).

May 27th. Ordinary Meeting at 8 p.m.

Institution of Civil Engineers.

May 5th. Special Meeting.

EXHIBITIONS.

The second Northern Colliery and Mining Exhibition will be held in the City Exhibition Hall, Manchester from June 12th to June 27th.

A Gas Industry Exhibition will be held at Munich from 1st to 31st July.

THE SALT INDUSTRY.

By GEOFFREY MARTIN, Ph.D.

Lecturer on Chemistry at the Birkbeck College, London University.

THE salt industry is not only one of the most important, but also is one of the oldest of chemical industries. From time immemorial salt has been obtained from the sea and from natural brine. In fact, some eighteen centuries ago, the Romans carried on a thriving industry in salt in Great Britain, remains of old Roman salt pans having been discovered in many parts of the country.

White salt is at present obtained on the large scale from two main sources, namely, from the sea and from solid rock-salt. Each will be described in turn.

Manufacture of Sea Salt.—The waters of the ocean contain a practically inexhaustible supply of salt. Thus, 100 gms. of sea water contain :—

	Atlantic.	Mediterranean.	Dead Sea.
NaCl ..	2.733 gms.	3.007 gms.	8.79 gms.
MgCl ₂ ..	0.334 "	0.385 "	8.99 "
MgSO ₄ ..	0.225 "	0.249 "	—
CaSO ₄ ..	0.126 "	0.140 "	0.14 "
KCl ..	0.077 "	0.086 "	1.36 "
MgBr ₂ ..	0.008 "	0.008 "	0.37 "
CaCO ₃ ..	0.012 "	0.012 "	2.38 "
Total Salts	3.505 gms.	3.887 gms.	22.03 gms.

It will be seen that sea salt is very impure. To every 100 gms. of sodium chloride (*i.e.*, common salt) present in sea salt we have about 12.3 gms. magnesium chloride, MgCl₂; 8.3 gms. magnesium sulphate, MgSO₄; 4.6 gms. calcium sulphate, CaSO₄; 2.8 gms. potassium chloride, KCl; 0.3 gms. magnesium bromide, and 0.4 gms. calcium carbonate, CaCO₃.

It is clear, therefore, that it would never do simply to allow sea water to evaporate dry. The salt must be extracted from it by a process of fractional crystallisation.

This has been done for ages by the following process, which is still largely worked in countries rich in sunshine, such as France (where 500,000 tons of sea salt are annually obtained), Russia (900,000 tons of sea or solar salt), Tunis, Spain, Portugal, United States, etc. A strip of flat clay soil near the seashore and well below the high-water mark, is levelled, divided into a series of compartments by walls, and the whole is rendered watertight by puddling with clay. Next, at the spring tides the sea is allowed to enter the first compartment A (often covering many acres of land), and is allowed to stand in this shallow pond until the sun and warm weather has evaporated much of the water, the concentration being allowed to increase from 3.5° Bé. to 25° Bé., *i.e.*, nearly to the saturation point. There separates out at this stage clay, calcium carbonate, calcium sulphate, and various other sparingly soluble im-

purities. By means of special sluices, the concentrated sea water is now allowed to flow into the second tank B, where the water is allowed to evaporate until the concentration has risen to 27° Bé., and fairly pure sodium chloride, NaCl, separates out as fine white crystals, usually of 95–97% purity (Fig. 2).

The mother liquors from the crystallising tanks B are now allowed to run into a third pond C, where concentration proceeds until 32° Bé. is reached, when sodium chloride of somewhat inferior quality is obtained. The mother liquors from this impure



WIELICZKA SALT MINE. MASSES OF TRANSPARENT CRYSTALS.

salt are then usually run to waste. Sometimes, however, they are worked up for bromides and iodides, a considerable amount of these two elements being separated in France. The crystals of salt obtained in the tanks are then raked together into heaps, and are allowed to stand in the air, exposed to occasional showers.

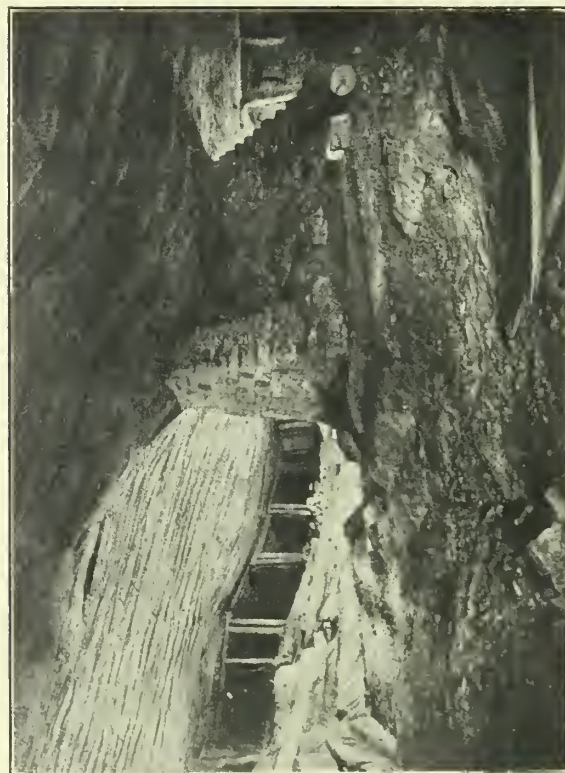
The deliquescent magnesium chloride, attracting moisture from the air, is thus to a great extent washed out of the mass.

In good seasons each square metre of surface will yield in 40–50 days some 50–80 kilos. of salt.

The salt thus obtained is called "solar salt." In former times it was practically the only source of salt, but at the present time much more salt is obtained from:—

Rock Salt.—It is almost impossible to give the reader an idea of the perfectly enormous deposits of rock salt which occur in various parts of the world. In India and Spain whole hills, often some miles in

circumference, occur. Hundreds of square miles of the Sahara Desert are covered with a snow-like deposit of salt, the dried remains of prehistoric seas. Besides this extensive deposits of rock salt, of unknown thickness and extent, occur in other parts of this desert, and have been worked for thousands of years by the primitive inhabitants of these regions. In America, Russia, China, India, and Europe vast deposits of rock salt are met with. Perhaps the most astonishing deposit of salt occurs at Stassfurt, in Germany, where the salt exceeds 3,000 ft. (*i.e.*, over half a mile) in thickness, and is first reached at a depth of about 800 ft. However, the most remarkable salt mines in the world occur at Wieliczka, in Austria, where the reader may see vast chambers hewn out of glittering snow-white rock salt, as well as churches, ballrooms, great broad staircases, statues and monuments, and even houses—all built out of the same mineral. In this region the deposits are over 1,200 ft. thick and extend some 500 miles. In parts of the mine the salt is practically pure, occurring in 100% NaCl masses, and does not need any purification for use. It is simply ground to a powder and sent into commerce. In this mine, too, are to be seen perfectly transparent masses of rock salt. A few illustrations are appended of views of some parts of these wonderful mines, although they fail altogether to give the



WIELICZKA SALT MINE. STRATIFIED LAYERS OF SALT.

reader an idea of the magnificence of the scenery in certain parts of the mines. The extreme regularity of the strata of rock salt will be noticed.

The main British deposits of salt occur in

Cheshire and Lancashire, while it is also found near Carrickfergus and near Larne, in Ireland.

At Northwich, in Cheshire, two beds of salt exist, the upper bed being 75 ft. thick and about 130—150 ft. below the surface. Under this is a 30-ft. layer of hard marl, and then comes the second bed of salt, which is 105 ft. thick. Similar beds occur in other parts of the country.

There are several ways of obtaining the white salt of commerce from rock salt. Where the rock salt is pure and white (as in parts of the Wieliczka mines), it is simply mined by ordinary methods, using ordinary black powder for blasting. At the end of each gallery is a grinding mill, and the salt is ground up and then sent up for export. However, as a rule rock salt is not a pure white mass. It is usually contaminated with clay and earthy matter, being often stained by metallic oxides (especially iron oxides) to a grey, rose, brick red, yellow, violet, blue, and even green colour, and so has to be purified from these contaminations. The usual way to do this is to sink a shaft down to the salt beds, and then run fresh water down. The rock salt is rapidly dissolved by the water, and the "brine" so obtained is left in contact with the salt until it is saturated, and is then pumped to the surface, piped away to "salt pans" and boiled down for salt. Where the salt lies at a great depth below the surface, the salt

being overturned, and the drainage of a district being destroyed. It has been proved that the water finding its way down to the rock salt beds often runs for miles along its surface, and so an ever-increasing layer of salt is removed, with bad effects for the superlying land.

The saturated brine thus obtained is piped away to the "salt pans" for boiling down.

Fig. 1, shows a section through a typical English salt pan. A is the "pan"—a rectangular iron vessel, made of riveted boiler plates, and resting on brickwork fire flues, the fireplaces being in front. These pans are 20, 30, 60, and even 150 ft. long, and are from 12 ins. to 2 ft. in depth. BBB are the flues, through which the hot gases from the fire streams, heating the pans placed above.

The salt as it separates out in the pan is raked to the sides and then shovelled out by means of a kind of perforated shovel, and thrown wet and dripping on the "hurdles" D. In this operation the workmen stand on the wooden gangways CC, which run the whole length of the pans. The brine running off from the salt placed on the hurdles D, runs into a gutter E, and thence back to the pan A.

The grain of the salt varies with the temperature at which the evaporating brine is kept, boiling brine giving fine "butter salt" or "lump salt." In this case the pans are small, usually 20—25 ft. long, and the salt as it settles out is raked off the fire plates to the side of the pan, and is withdrawn every 7—12 hours, being thrown into wooden boxes. On cooling the hot brine still contained in salt crystallises and cements the whole into a solid lump, which is then knocked out of the box and dried in a drying chamber. Table salt is prepared from this fine-grained salt by merely grinding. The best varieties of German table salt are prepared by removing the salt from the pans by means of perforated shovels, dumping on dripping boards, where the excess moisture runs away, then throwing into centrifugal machines, where the drying is further completed. The final drying takes place in rotating copper cylinders lined with cement (copper is attacked by salt) and provided with a rotating worm, which transfers the salt through the chamber against a current of hot air. The worm keeps turning the salt over and over, and it emerges quite dry and free from lumps, with a brilliant white crystalline surface.

Table salt usually contains 97.4 to 97.5% NaCl; 0.5 to 1.3% CaSO₄; 0.08 to 0.3% MgCl₂; 0.03% insoluble residue, and 0.0 to 1.6% moisture. Magnesium chloride, MgCl₂, if present in salt to any great extent causes an intensification of the salty taste, but, being hygroscopic, it causes the salt to become lumpy and damp. It should, however, be noted that even the purest samples of salt have a tendency to stick together in lumps. This difficulty is got over in some brands of table salt by adding a small amount of bone meal (calcium phosphate) to it. Thus in a recent lawsuit it was stated that Cerberos salt contained about 3% of mineral phosphate.

The slower the evaporation, the larger the grain of the salt. Thus, "common salt," as used in certain

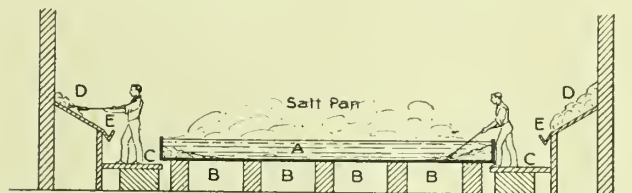


FIG. 1.—ENGLISH SALT PAN (CROSS SECTION). A, SALT PAN; B, FLUES; D, HURDLES, WITH GUTTER E FOR DRAINING.

is mined in the usual way, and into the cavities thus obtained fresh water is allowed to flow, in a systematic manner, so that great cavities are thus dissolved out in the heart of the rock salt. However, care is taken to leave supporting pillars of rock salt at fixed intervals, so that the roof does not collapse. In Cheshire, however, the rock salt is reached at a depth of only about 159 ft., and so merely a shaft is sunk until the rock salt is reached, then fresh water is allowed to flow down the shaft (the sides of shaft being usually protected from the solvent action of the water by iron piping, timbering, etc.), and when saturated is pumped up again. The concentrated brine is heavier than pure water, and so collects at the bottom of the shaft, and so care is taken to draw only from the bottom of the shaft, and the pumps are only worked until the brine comes up almost saturated, as weak brine requires expensive fuel to evaporate the excess of water. However, the removal of these subterranean beds of salt by agency of water in this manner has caused very serious subsidence of the land above them. It is by no means rare in brine pumping districts for pieces of land to sink some 12 ins. a year, hills becoming converted into water-filled hollows, walls and houses

manufacturing operations, is made by allowing the salt to crystallise out at 60—80° C. in pans some 40 ft. long, the salt being drawn from the pan every 24 hours. *Fishery salt*, still coarser-grained, is made by crystallising the brine at 38—60° C. in large pans, often 60 ft. long, the salt being removed every week or fortnight.

Bay salt, a still coarser-grained salt, is made in pans some 149—160 ft. long, the brine being kept at 30—40° C., and the crystals of salt being allowed to grow for 3—4 weeks before being withdrawn from the pans. "*Hopper*" salt is made by adding alum to the pans, when the salt crystallises out in hollow masses, which float about before they sink.

The manufacture of salt by these processes has been practically unaltered for centuries. Recently, however, efforts have been made to introduce "vacuum pans" for causing the rapid evaporation of the brine. Vacuum evaporators consist of cylindrical closed vessels, usually conical at the bottom, for the purpose of collecting the salt. Each vessel is provided with a bunch of heating tubes, through which steam passes, thus causing a transfer of heat from steam to brine. The steam which is evolved from the boiling brine of one vessel is passed into the heating compartment of the second vessel, and the steam from the second vessel into that of a third or fourth, so that the steam of each vessel is used for heating the next, the last vessel of the series being connected with a vacuum pump, whereby the brine is made to boil at a lower pressure.

According as three or four such vessels are used, the apparatus is known as a "triple" or "quadruple" effect evaporator. The introduction of these vacuum evaporators into the salt industry has increased the yield of salt per ton of fuel burnt to a very great extent. For example, an ordinary open

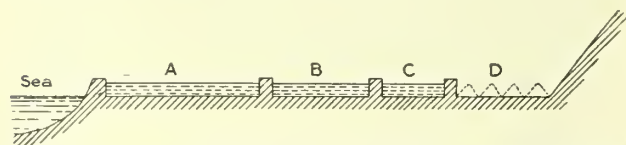


FIG. 2.—SEA SALT WORKS. A, FIRST CONCENTRATION TANK; B, FIRST CRYSTALLISING TANK; C, SECOND CRYSTALLISING TANK; D, HEAP OF SALT EXPOSED TO ATMOSPHERE, MAGNESIUM CHLORIDE BEING WASHED AWAY.

pan seldom yields more than 2½ tons of salt per ton of fuel burnt. With vacuum plant, however, one ton of fuel will yield 6 or 7 tons of salt. Moreover, the productive capacity of vacuum pans is far greater than that of open pans. Thus while an ordinary open pan yields but 15—20 tons of salt per 24 hours, multiple effect vacuum pans are built which in the same time will give some 500—800 tons of salt. The main disadvantage of vacuum pans, however, are the heavy initial outlay, and the care with which the brine has to be purified in order to prevent the scaling over and blocking up of the heating tubes. Thus, in brine there is always a considerable amount of magnesium and calcium sulphates, also calcium and magnesium carbonates and bicarbonates. When the brine is evaporated these separate out and cover

the metal heating surface with a rock-like scale, which eventually seriously damages the machinery.

Consequently, before passing into the vacuum pans, the brine must be freed from such impurities. Many suggestions have been made for doing this. One of the best expedients seems to be to add calcium chloride, CaCl_2 , to the brine during evaporation. This causes the calcium sulphate (the principal cause of the scaling effects) to precipitate in the form of small crystals, which do not form an adherent scale, but mix with the salt and so leave the apparatus with the salt. The Triplex Co., at Lüneburg, treat the brine with some milk of lime, which precipitates the magnesium salts as $\text{Mg}(\text{OH})_2$, and also precipitates any calcium bicarbonate present.

Next, ammonium carbonate liquors are added, which precipitate all the calcium present as carbonate. The precipitated calcium carbonate is allowed to settle, and the purified brine thus obtained is run into triple effect vacuum pans and boiled down. The mother liquors remaining after the salt has crystallised out contains the added ammonium salts, which are recovered by boiling off the ammonia by adding lime, the expelled ammonia being once more converted into ammonium carbonate and so is used over again. The salt thus obtained comes down as a finely grained mass of almost chemically pure sodium chloride (99.8% NaCl).

All vacuum pans cause the separation of the salt in a finely divided condition, and where coarse-grained salt is necessary, the use of large open pans is resorted to.

The great saving in fuel effected by the introduction of vacuum pans will no doubt effect a great saving in the cost of production of salt, where the fuel bill eats heavily into the margin of profit.

An interesting development of the salt industry has recently taken place. The problem of utilising rock salt for the direct production of white salt suitable for commerce and edible purposes, instead of making it from brine, has long occupied the attention of inventors. This will be obvious when it is recollected that one imperial gallon of saturated brine will only yield on evaporation some 50 ozs. of dry salt. Thus there is a great fuel consumption necessary for the evaporation of brine to dry salt.

Now, as we have seen, ordinary rock salt contains clay and gypsum, and is coloured by iron and metallic oxides to all sorts of tints, ranging from brick-red to green or violet. Hence, in order to produce a commercial salt of good quality direct from rock salt, we must remove all traces of these staining impurities. Now the temperature at which salt fuses, viz., 776° C., is so much lower than the very high fusion temperature of the impurities contained therein, that it is possible to purify it by fusion alone. A great many attempts have been made to purify by fusion, but until very recently, with no commercial success. It is stated that Tee, working for the International Salt Co., whose works are at Carrickfergus, in Ireland, has overcome these difficulties, and that the process may in time revolutionise the salt industry. Tee found in the laboratory, that when salt is melted in an ordinary

crucible, and agitated by a stream of air, and then is maintained molten for a considerable time, the impurities settle out at the bottom, sinking through the molten salt. On cooling the whole of the earthy impurities deposit at the bottom in distinct laminæ, the separation showing a straight, well-defined line, the bulk above it being pure white salt of a good appearance.

Tee next carried out experiments on the large scale. The crude rock salt was melted in a furnace of the same type as an open hearth steel furnace, and was then run into large vessels, termed "converters," into which air was blown. The salt on cooling shrunk away from the walls, and gave a similar line of demarcation between the pure salt and the impurities as had been obtained on the small scale. However, very great practical difficulties were encountered. The clayey matter became viscid and formed a clog upon the bed of the furnace, which prevented the free running of the salt into the converter, and caused much salt to remain behind mixed with clay.

The yield of pure salt thus obtained made the process hopeless from a commercial standpoint. Consequently, it was found necessary to depart altogether from an ordinary metallurgical furnace.

An internal platform was made in the furnaces, upon which crushed rock salt was discharged at various openings, and accumulated along the platform in the form of cones. When these cones of rock salt melted under the heat of the furnace, the melted salt flowed away, leaving a residue of clayey matter, etc., capable of being easily removed. The molten salt flowed down to the bed of the furnace, and when sufficient of the molten fluid had collected, air was blown through the salt in the furnace itself, thus doing away with the converters. The molten salt is then allowed to stand some time in a fluid condition, in order to allow the impurities to settle, when it is run into moulds, where it is quickly cooled; the salt is then transferred to the crushing and grading machinery, where it is graded into the different kinds of finished salt.

It is stated that 1 ton of coal will, by this process, give about 12 tons of finished, purified salt.

The first patent of Tee was taken out in 1903, and several patents have since been taken out by him at subsequent intervals.

Tee estimates that, exclusive of the price of rock salt, the price of its conversion into the pure graded commercial product, including depreciation upon apparatus, will not exceed 2s. 6d. per ton. There is much saving of labour as well as fuel by the Tee process, and a great increase in turnover on the capital invested, as compared with the brine process using open pans. Whether the process will be able to compete with the vacuum pan method remains to be seen.

Of the various uses of salt it is scarcely necessary to remind the reader. Salt is an essential component of all animal food, usually entering the body already contained in the substances we eat. Deprive a man of all salt by feeding him on material devoid of this

mineral, and he slowly but surely dies. In fact the Chinese used this method of torturing to death their worst criminals. Despotie Governments ail over the world have taken advantage of this vital necessity for salt in order to raise revenue by taxing all supplies of salt—a tax which in its former oppressive form caused much ill health among the poorer classes. Most progressive countries have abolished this tax, but in a mild form it still lingers in France, Germany, Italy, India, and other countries. In countries where supplies of salt are difficult to obtain—such as parts of Central Africa—the physiological craving for salt of the natives takes a very surprising form. In such countries salt is prized so highly that the little children may be found sucking pieces of rock salt, much as children in European countries suck sugar in the form of sweets. In fact, a considerable industry in this commodity takes place even in very wild districts of Africa.

However, far larger quantities of salt are consumed in the arts for various purposes. Thus, the whole of the enormous alkali industry starts from salt as the raw material for its sodium. The chlorine of salt reappears in bleaching powder and hydrochloric acid, and salt is also used for glazing pottery, in soapmaking, and in hundreds of other branches of human activity.

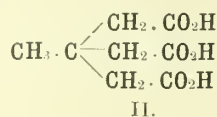
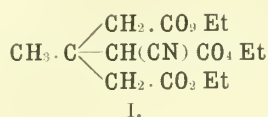
NOTES ON RECENT THEORY AND PRACTICE.

By HERBERT H. HODGSON, M.A., B.Sc., Ph.D.

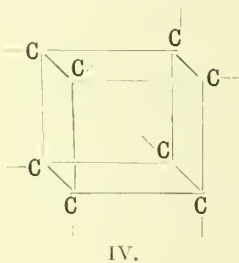
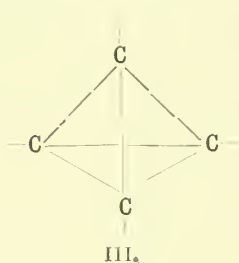
ULTRA-VIOLET light as a chemical agent finds ever more extended application, and in this connection an interesting paper by W. T. Bovie (*Science*, 1913, 37, 24—25 and 373—375) deserves attention. The above investigator found that by exposing certain proteins in quartz tubes to the rays of a quartz mercury-vapour lamp, coagulation ensued. As a rule glass tubes are inimical to this effect, although dialysed egg-albumin is sensitive to longer wave-lengths than the fresh egg-white, since it coagulates in a glass tube. The coagulum produced by heat has the same properties as that obtained by ultra-violet light. Two reactions appear to be involved in this operation, viz., the chemical change caused by the light and the subsequent coagulum formation. The light reaction, analogous to other photochemical changes, has a very low temperature coefficient, while the chemical change resulting in the production of the visible coagulum has a temperature coefficient as high as two.

Of more than average interest is the preliminary note by R. M. Beesley and J. F. Thorpe (*Chem. News*, January 16th, 1914) on a "New Series of Ring Compounds." Here the condensation of the ethyl ester of labile β -methylglutaconic acid with the sodium compound of ethyl cyano-acetate, yielding the cyano-ester (I.) and the almost quantitative yield of the tricarboxylic acid (II.) obtained from it by hydrolysis, led the authors to an investigation in

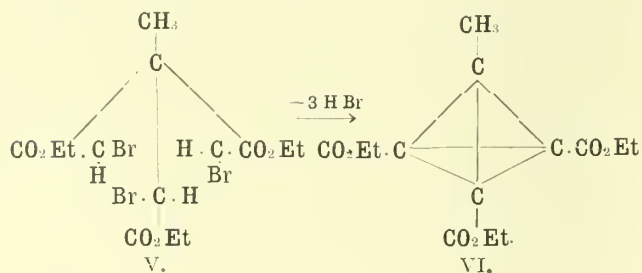
which the possibility of the existence of "enclosed" or "caged" carbon rings has been studied.



The simplest type of such a series would be the enclosed four-carbon ring in which the carbon atoms occupy the four points of a tetrahedron (III.), while another would be the "caged" cube (IV.).



Now the esters of the the bromoglutaric acids eliminate hydrogen bromide and pass into derivatives of cyclopropane, so that if this reaction could be applied to the tribromo-ester (V.) ring formation would ensue in accordance with the schemes (V. and VI.).



Grave experimental difficulties were encountered in the elimination of the hydrogen bromide, since all the usual reagents led to the production of the corresponding lactones. It was found, however, that by adding the bromo-ester to a very concentrated aqueous solution of potassium hydroxide at 130° C., a very violet reaction occurred and, what was most remarkable, that the greater the violence the better the yield of the ring compound. The tribromo-ester (V.) was thereby converted into a tricarboxylic acid of formula $\text{C}_8\text{H}_6\text{O}_6$, which body has all the properties of a "caged" ring compound. The authors are continuing this investigation, which is of the highest importance as well as of the most novel character.

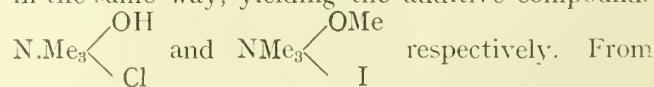
The partition of colour substances between two solvents forms the subject of an ingenious contribution to the theory of dyeing by W. Reinders (*Kolloid. Zeitsch.*, 1913, 13, 98—105). A series of partition experiments with a set of organic colouring matters were carried out with water and isobutyl alcohol, the aqueous layer being acidified or made alkaline in several cases. The dyes under considera-

tion were methylene blue G (conc), methylene-blue D, magenta, crystal-violet, new magenta, crystal ponceau, patent blue, erythrosin, roccellin, quinoline yellow, alkali blue, and congo red. The author shows that nowhere does the simple partition relationship exist, but that in some cases the factor $1/n$ of the adsorption formula $x/m = ac^{1/n}$ is constant and generally <1 . Comparison is made between these results and those for colouring matter and fibre, the conclusion drawn being that the dyeing of a fabric consists mainly in forming a solid solution, the assumption of an adsorbed layer being unnecessary.

An ideal electro-capillarity curve has been experimentally found by F. Krüger and H. Krumreich (*Zeitsch. Elektrochem.*, 1913, 19, 617—622) for potassium nitrate and potassium nitrate containing mercurous nitrate, in the form of an exact parabola. This result is in agreement with the electrical theory of electro-capillarity of Lippmann, Helmholtz, and Nernst.

The determination of molecular weights by the observation of some physical property always offers a fascinating avenue of research, and in this respect the work of Vladimir A. Kistiakovski merits notice. In 1906 (*Zeit. Elektro Chem.*, 1906, 12, 513—14) this investigator formulated a rule for capillary phenomena analogous with Trouton's Rule for the Latent Heat of Evaporation. He showed that for forty non-associating liquids the value of $a \cdot M/T$ lies between 0.0101 and 0.0119, the mean value being 0.0116, where "a" is the height to which the liquid would rise in a tube 1 cm. in diameter at its boiling point, N is the molecular weight, and T the absolute boiling point. Associating liquids give smaller values for the constant. The author has now extended this work (*J. Russ. Phys. Chem. Soc.*, 1913, 45, 782—801), and placed it upon a theoretical basis, showing that molecular weights may be calculated by means of this rule for compounds in both the liquid and gaseous phases. With associated liquids, however, it is impossible to make direct application of the value of the constant for the calculation of their degrees of association. The results obtained show that the capillarity method may be recommended for determining molecular weights in the liquid or gaseous phases of aliphatic and aromatic hydrocarbons and their halogenated derivatives, aliphatic and aromatic amines, ethers, and esters, aromatic aldehydes and ketones.

By reason of the great importance of the subject, E. Fromm (*Annalen*, 1913, 399, 366—370, 371—376, 377) has subjected Meisenheimer's recent proof of the non-equivalence of the five valencies of the nitrogen atom to searching criticism. This author is of opinion, that Meisenheimer's experiments can be interpreted in another and more probable manner. The latter assumes that HCl and CH_3I both attack trimethylamine oxide at the same point and in the same way, yielding the additive compounds



the former by the action of sodium methoxide, and

from the latter by moist silver oxide, are obtained the substances $\text{NMe}_3 \begin{smallmatrix} \text{OH} \\ \text{OMe} \end{smallmatrix}$ and $\text{NMe}_3 \begin{smallmatrix} \text{OMe} \\ \text{OH} \end{smallmatrix}$, and

the different behaviour of these during decomposition is the foundation of Meisenheimer's proof of the difference of the fifth "unique" valency of nitrogen from the other four. Fromm takes exception to this, and argues that since the two bodies

$\text{NMe}_3 \begin{smallmatrix} \text{OH} \\ \text{OMe} \end{smallmatrix}$ and $\text{NMe}_3 \begin{smallmatrix} \text{OMe} \\ \text{OH} \end{smallmatrix}$ are alcoholates of

a very feeble base, viz., $\text{NMe}_3(\text{OH})_2$, they must both be hydrolytically dissociated by water and yield MeOH and $\text{NMe}_3(\text{OH})_2$ if they have the constitutions given above. Fromm is also of opinion that HCl and CH_3I do not attack trimethylamine oxide in the same manner. With

CH_3I the oxide forms the methiodide, $\text{NMe}_3 : \text{O} \begin{smallmatrix} \text{Me} \\ \text{I} \end{smallmatrix}$, and the reaction product with moist silver oxide

would then be $\text{NMe}_3 : \text{O} \begin{smallmatrix} \text{Me} \\ \text{OH} \end{smallmatrix}$ yielding trimethylamine, formaldehyde, and water on decomposition, which is actually the case. The formula

$\text{NMe}_3 = \text{O} \begin{smallmatrix} \text{Me} \\ \text{I} \end{smallmatrix}$ has been discussed and rejected

by Meisenheimer, but the author considers the reasons for its rejection insufficient. In reply to Fromm's criticisms, Meisenheimer claims that the whole behaviour of ammonium compounds proves that four of the valencies of the nitrogen atom are negative while the fifth is positive, and therefore in the addition of HCl to trimethylamine oxide, the negative chlorine will become attached only to the fifth and positive valency of the nitrogen atom, thereby producing only one additive compound. To Fromm's criticism that the two isomerides,

$\text{NMe}_3 \begin{smallmatrix} \text{OH} \\ \text{OMe} \end{smallmatrix}$ and $\text{NMe}_3 \begin{smallmatrix} \text{OMe} \\ \text{OH} \end{smallmatrix}$ should both be

hydrolysed by water, the author replies that only one, viz., that in which the methoxy group is attached to the fifth positive valency of the nitrogen atom, should be hydrolytically dissociated; the other isomeride, in which the methoxyl group is bound by a negative valency, should be as little affected by water as is methoxylamine $\text{OMe} \cdot \text{NH}_2$. Fromm agrees with Meisenheimer that in ammonium compounds the fifth "positive" valency of the nitrogen atom is different from the other four "negative" valencies, but is of opinion that the results of observations on ammonium compounds cannot be applied to the case of the amino oxides without further consideration, claiming that in these oxides there are two "positive" valencies which differ from the other three "negative" ones.

Ortho-tolidine has been found serviceable for the colourimetric determination of small quantities of free chlorine in water by J. W. Ellms and S. J. Hauser (*J. Ind. Eng. Chem.*, 1915, 5, 915-917). An

acetic acid solution of ortho-tolidine had previously been suggested by E. B. Phelps for the detection of free chlorine in water which has been disinfected by chlorine or hypochlorites, but the first named authors find that by using hydrochloric in place of acetic acid the test may be extended to quantitative work. One hundred cubic centimetres of the water are treated with 1 c.c. of a 0.1% solution of o-tolidine in 10% HCl , and, after five minutes the colour is compared with that of standards prepared in a similar manner with water which has been distilled with alkaline permanganate. A larger quantity of the reagent must be used if the water contain more than three parts of free chlorine per million.

O. Schewket (*Biochem. Zeitsch.*, 1913, 54, 282-284) has communicated some new colour reactions for di- and tri-phenols. Catechol treated with a few drops of 1% iodine solution in potassium iodide and then, after dilution, with a few drops of 5% NaOH solution, gives at once a bright green colour. The immediate production of this colour distinguishes catechol from resorcinol. Pyrogallol under the same conditions yields a transient violet colour. When an aqueous solution of the latter is diluted with half its volume of alcohol and a few drops of caustic alkali added, it gradually gives a violet colour similar to that of permanganate solutions, a test which serves to distinguish pyrogallol from phloroglucinol. When a hot dilute aqueous solution of the latter is treated with a few drops of 0.5% I in KI solution, decolourisation ensues, and on addition of a few drops of alkali forms a bright brown colouration which turns to reddish-violet on boiling. With H_2O_2 in alkaline solutions phloroglucinol affords a very stable bluish violet colouration, which gradually changes into red and then yellow on addition of acids, but is restored by alkalies. This test is very characteristic.

R. Willstätter and L. Zechmeister (*Ber.*, 1913, 46, 2401-2412) communicate Part I. of what will probably be a most important investigation on the hydrolysis of cellulose. They find that whereas ordinary concentrated hydrochloric acid (37.6% HCl) decomposes and gelatinises cellulose after about a day's action, a more concentrated acid (40-41% HCl) dissolves cellulose completely within a few seconds. At the outset the cellulose may be reprecipitated, but it is rapidly hydrolysed, only the final product dextrose remaining in solution. The change may be followed both polarimetrically and gravimetrically, whereby 96% of the theoretical quantity of dextrose is obtained. The 1% solution of cellulose in the concentrated acid is at first optically inactive, but becomes active after about an hour, this increasing until hydrolysis is complete, i.e., from 24 to 48 hours at the ordinary temperature. The change in rotatory power gives indication of the intermediate formation of higher carbohydrates. Cellulose dissolves similarly in 66% hydrogen bromide, but not in concentrated hydriodic acid; hydrofluoric acid (70-75% HF) gelatinises and quickly dissolves cellulose, while pine-wood rapidly dissolves in fuming HCl , leaving 30% of its weight undissolved as lignin substance.

An interesting and extremely convenient reaction for boric acid or for methyl alcohol has been proposed by E. Pieszezek (*Pharm. Zeit.*, 1913, 58, 850—851). If methyl alcohol be used instead of ethyl, the green flame colouration in presence of borates can be obtained even without addition of sulphuric acid. The test may thus be used for distinguishing the two alcohols and for detecting as little as 5—10% of methyl in ethyl alcohol. It is expedient to allow 1—2 minutes for the interaction of the alcohol and boric acid before igniting the alcohol vapour.

CURRENT LEGAL TOPICS.

Ore Separation Patent Action.

By WILLIAM JAGO, F.I.C.

LITIGATION has been proceeding for some years on the subject of patents for the separation of metalliferous compounds from gangue by the selective action of oil. An important judgment on this subject was delivered on March 6th by the Judicial Committee of the Privy Council as the result of an appeal from a decision of the Supreme Court of New South Wales. The parties were the Ore Concentration Co. (1905), Ltd. and the Australian Ore Concentration Syndicate, Ltd., appellants, and the Sulphide Corporation, Ltd., respondents. The original action was brought to restrain the respondents from infringing letters patent of New South Wales, No. 10,001 of 1900, granted to F. E. Elmore, and No. 11,307 of 1901, granted to A. S. Elmore. The former patent was abandoned at the trial, and its only effect on the action was as an element possibly affecting the novelty of the invention claimed in the patent of 1901 granted to A. S. Elmore.

In view of the rather indefinite ideas of patentees on the subject of novelty as affected by the existence of previous patents, it may be well to deal somewhat closely with the point. For the moment, any effect of the Act of 1907 is not being considered. If A. B. in 1904 patents an invention for any particular process, and effects improvements therein during that year, he may very possibly take out a new patent in 1905 for his improved invention. He may, however, find himself in this difficulty: His own patent of 1904 may have so anticipated that of 1905 that there is no residual novelty in the later sufficient to sustain a patent, and his second patent may be void as the result of the same patentee's earlier patent. This is a catastrophe that has in fact been the rock on which patents have split before to-day. A case has recently come within the writer's personal knowledge in which a patentee had to face the difficulty of his invention having been anticipated by a previous patent. At least that was the opinion of his professional advisers. As a measure of defence,

the second patentee bought up the invention comprised in the first patent. No doubt by thus satisfying the earlier patentee the second has materially strengthened his position, since the former is not likely to take any steps in the matter. But as against the general public the position has not been improved, since anyone may cite the earlier patent as an anticipation and claim that the latter is void through lack of novelty. A remedy is provided by the Act of 1907, as now any improvements or auxiliary inventions may be covered by a "patent of addition."

The judgment of the Committee of the Privy Council was delivered by Lord Parmoor, who, as Sir Alfred Cripps, K.C., was formerly well known as leading counsel in patent cases. Dealing with the state of the art, it was pointed out that for many years prior to 1901 it was common knowledge that oil operated to differentiate metal from gangue in a mixture of oil, water, and ore. Further, it had been shown that the addition of an acid, acid salt, or even a neutral salt to such a mixture conducted to the breaking up of the mass and the liberation of metals or metallic minerals from the mixture. An authoritative description of this process was given in the *Engineering and Mining Journal* in 1890, by a correspondent who had witnessed a test in which finely crushed sulphide ore was thoroughly mixed with thick black oil. Water heated to nearly boiling was rendered slightly acid by the addition of sulphuric acid ("enough acid to give it a tartish taste"), and then mixed with the mass of oil and ore. The sulphides and oil rose as a scum to the top, leaving behind a white sediment of silica. Subsequent experiments tended to show that the presence of carbonates was necessary in the ore in order that the acid-oil treatment could be effective. On behalf of the respondents it was urged that this was an anticipation of Elmore's Patent, in reply to which the appellants argued that the directions as to quantity of sulphuric acid were too vague, to which again the answer by the respondents was that the directions as to quantity were sufficient for the purpose and in any case not more vague than the directions in Elmore's Patent.

A point of great general importance occurs at this stage of the judgment on the construction of documents. A question was put to one of the witnesses for the respondents, in which he was asked to read this document published in 1890 in the light of the knowledge which he would have in 1901. The rule laid down by the Committee of the Privy Council is so important as to justify its being quoted *in extenso* :—

"It is a general canon of construction, applicable to all documents, that the document should be construed as if the Court had to construe it at the date of publication, to the exclusion of information subsequently discovered. In patent cases the observance of this canon of construction has great importance. It is common in such cases to have a number of documents placed in evidence extending over a considerable period of time, each of which is relied on as

disclosing relevant information prior to the date of the patent. If these documents require the assistance of experts to aid the Court in construction, the Court is deprived of the benefit of such assistance if the witness is asked to read the document not in reference to what was known at the date of publication, but to knowledge only acquired at some subsequent date."

There is probably no other class of case in which this rule has such a direct and vital application. It is very difficult to follow, but one of the duties of the chemical or other expert witness, who has thus to render assistance to the Court in the interpretation of a series of scientific statements of different dates is to ask himself what would this mean to me at the time of its original publication?

The earlier Elmore Patent, that of F. E. Elmore in 1900, was next touched on. This was for a method of separation by mixing the finely pulverised ore with water and then adding more or less thick oil. The oil floated up the metallic constituents, and the remainder subsided to the bottom of the water layer. The oil was separated from the metallic matter by a centrifugal machine. It should be noticed that this patent does not refer to the use of acids as a part of the process of separation.

The judgment next deals with the later or A. S. Elmore patent of 1901. The title is "Improvements in the process and apparatus for separating mineral substances by the selective action of oil." This "selective action of oil" figures very prominently throughout the whole specification. At the outset, the F. E. Elmore (1900) method is described, insistence being laid down on the necessity of using oil having sufficient tenacity to retain the entrapped metallic particles. This may be regarded as a recital of the state of the art. The patentee next goes on to describe his own invention, and states that in carrying on "this separating process," he has discovered that in some cases a slight acidulation greatly enhances the selective action of the oil. The quantity of acid required is small and often need not exceed one five-hundredth of the volume of oil or water employed.

The patentee neither suggests nor gives any scientific explanation of the reasons why the presence of acid should be of assistance in effecting the separation. In this he is probably wise, since it is no real part of the functions of a specification to explain the theory or scientific causes which may underlie the invention it is sought to patent. The protection of a patent is given in return for the introduction of a "new manufacture" within the realm. The manufacture and how it is practised must be clearly described, but theoretical considerations are best omitted unless actually necessary in order to make clear the mode of manufacture and its novelty.

The claim in the specification is: "In processes for separating minerals by the selective action of oil, the addition of a small quantity of acid, etc." It first of all became necessary to determine the meaning of the phrase "selective action of oil," which the appellants contended is referable only to

conditions where the oil has a free choice between the two kinds of particles, selecting one and leaving the other, such conditions only prevailing in a freely flowing pulp. This was not seriously questioned, but the respondents contended that the expression "the selective action of oil" was referable only to conditions in which the oil is present in sufficient quantities to entrap or coat or absorb the metallic particles, and is of sufficient tenacity to carry these particles in the process of separation, whether by buoyancy or in the form of oil globules. Their Lordships were of opinion that this contention is well founded. The invention claimed was then defined by them as "the enhancement of the action of oil as a solutive agent by the addition of a small quantity of acid to the oil or water in any process of separation in which the oil is adequate in quantity and of sufficient tenacity to entrap or coat mineral particles until separation is effected."

On the question of validity the Judicial Committee decided that the "discovery of the patentee was at the date of the patent both novel and useful, resulting in a new process of commercial importance and value." The decision was, therefore, in favour of the patentee on the question of validity.

On the issue of infringement, there was little dispute as to facts. The respondents admitted, *inter alia*, that they used "at relevant dates a process in which a mixture consisting of oil, water, and oleic acid was in the initial stage slightly acidulated, in which sulphuric acid was added to a mixture of ore, water, and oleic acid." They alleged, however, that their process could be worked usefully without any admixture of oil. But as they did in fact use oil, the question of infringement must be decided on that basis. The point which had to be determined was whether the respondents entrapped the metallic particles in oil, using oil as the selective agent. The contention of the respondents was that their process did not depend on any such selective action, but that its successful operation was governed by the laws of surface tension. Professor Pollock, one of the witnesses for the respondents said: "I think that the main fact that underlies the working of the defendants' (respondents') process is that water in the presence of air wets the gangue material but does not wet the metallic particles. While the Board was careful to avoid the complete acceptance of Pollock's theory, it went so far as to say that "he shows that surface tension might account for the success of the respondents' process." They found, however, that apart from any question of theory the respondents use oil in their process under conditions which make it almost impossible to entrap the metallic particles by the selective agency of oil. They use a thin oil at a temperature of 120° F. and not more than 2 to 3 lbs. per ton of ore, or about 2 or 3 pints of oil to 10,000 pints of water. Further, the resulting concentrate is practically free from oil. Finally their Lordships accepted the views of Pollock, that the small quantity of oil used in the respondents' process does not necessarily perform any other function than causing a permanent froth and an extremely minute emulsion,

and especially does not act by any selective action of the metallic particles by the oil. On this evidence, the Judicial Committee found that the respondents do not, either directly or indirectly, use the invention claimed by the appellants, but a process

essentially distinct, and that there is no infringement.

Such was the conclusion of an exceedingly interesting and important example of patent litigation.

SURFACE TENSION AND SURFACE ENERGY AND THEIR INFLUENCE ON CHEMICAL PHENOMENA.

By R. S. WILLOWS, M.A., D.Sc., and E. HATSCHEK.

CHAPTER II. (*Continued*).

NEVERTHELESS, this molecular attraction exists and shows itself, when the gas is strongly compressed—and the distance between the molecules is greatly reduced—by causing deviations from Boyle's law. If we consider two layers of molecules, the distance between which is, of course, smaller than the radius of molecular attraction (Fig. 3), we see that their mutual attraction, or, in other words, the intrinsic pressure is proportional to the number of attracting molecules and to the number of attracted molecules, that is, proportional to the square

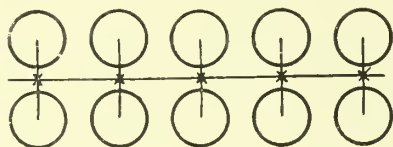


FIG. 3.

of the number of molecules. The number of molecules in unit volume is obviously proportional to the density, and we can, therefore, say that the intrinsic pressure is proportional to the square of the density

$$P = a\rho^2$$

where a is a constant and ρ the density. If we now call v the specific volume, *i.e.*, the volume occupied by 1 gm., $v = 1/\rho$, and we can write

$$P = \frac{a}{v^2}$$

This term enters into Van der Waals's equation for the volume of a gas at the pressure p and the temperature θ

$$\left(p + \frac{a}{v^2}\right)(v - b) = R\theta$$

and its value can be determined from the observed deviations of a gas from Boyle's law. If we assume that Van der Waals's equation applies approximately to liquids, as it undoubtedly does near the critical temperature, we find the intrinsic pressure of water to be about 11,000 atmospheres.

In view of the surprising value obtained in this way, it is desirable that we should have an alterna-

tive method of evaluating the intrinsic pressure. Such a method is available and is more instructive for our purpose, as it connects the intrinsic pressure with another important physical constant, the latent heat of vaporisation. This is the amount of heat required to transform 1 gm. of liquid into vapour without changing its temperature; for water at 100°, for instance, the latent heat $L = 540$ calories. To establish a connection between this constant and the intrinsic pressure we have to consider the work done in vaporising a liquid. This is of two kinds: molecules must be brought from the interior to the surface of the liquid and carried into the space above, against the pull exerted by the rest of the liquid, and the vapour thus produced must lift the superincumbent atmosphere. The portion of the latent heat used in doing the first part of the work is called the internal latent heat, L_i , since it arises from internal cohesive forces, while the portion used to overcome atmospheric pressure is called the external latent heat, L_e , which depends on the volume of the vapour and the atmospheric pressure to be overcome. If we call the atmospheric pressure, expressed in dynes, p , and the volume in cubic centimetres of 1 gm. of vapour v , the external latent heat $L_e = pv$ ergs, or pv/J calories, where J is the mechanical equivalent of heat, 42×10^6 . For water at 100° L , as mentioned, is about 540 calories, L_e about 40 calories, and L_i accordingly about 500 calories, or, in units of work, $500 \times 42 \times 10^6 = 21 \times 10^9$ ergs.

To connect the internal latent heat with the intrinsic pressure let us consider the forces to which a molecule of the liquid is subject. As long as it is in the interior of the liquid these are obviously equal in all directions, but the case is different when the molecule approaches the surface nearer than the radius of molecular attraction. Let O (Fig. 4) be such a molecule and describe round it a sphere with the radius C of molecular attraction; then only the liquid within that sphere will have any effect on O . In the position shown the molecule is attracted downwards by the liquid contained in the segment ab (equal to AB), as the downward attraction of the slab $abcd$ is balanced by the upward pull of the slab $ABcd$. This downward pull evidently increases until O is in the surface and decreases as O rises further above the surface, to become zero when the distance of O from the surface becomes C .

It is, therefore, obvious that half the work of moving the molecule from the interior of the liquid into the space above is done when the molecule is brought into the surface, and that the other half is used in dragging the molecule off the surface. The total work is, as explained above, the internal latent heat L_i , if we consider 1 gm. of liquid, and the work done in taking this gramme off the surface is therefore $\frac{1}{2} L_i$. It can be shown that this work is also equal to P ergs, where P is the intrinsic pressure expressed in dynes. We thus obtain the following value for P :—

$$P = \frac{1}{2} \times 21 \times 10^9 \text{ dynes,}$$

or, since an atmosphere is approximately 10^6 dynes,

$$P = \frac{1}{2} \times 21 \times 10^3 = 10,500 \text{ atmospheres.}$$

This value is in good agreement with the one obtained from Van der Waals's equation.

The magnitude of this cohesive force is surprising,

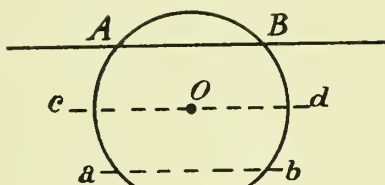


FIG. 4.

and it is desirable to have experimental demonstration of its existence and value. Experiments for this purpose have been made by various investigators, one of the first being due to Berthelot. He filled a narrow tube almost completely with water, a small bubble of vapour only being left in it. The tube was then warmed till the bubble disappeared and the water filled the whole tube. The tube could then be cooled without the bubble reappearing at once, so that the liquid was evidently stretched, the increase in volume in Berthelot's experiment amounting to about 1/400. The stress produced in the liquid by this extension could, of course, not be measured in the arrangement just described. This was, however, done by Worthington, who introduced into the tube a small bulb with a capillary stem filled with mercury. When the external liquid was stretched, as in Berthelot's experiment, the bulb expanded and the mercury indicated the amount of stress. Worthington examined the behaviour of alcohol between +12 and -17 atmospheres' pressure, and obtained the very important result that the modulus of elasticity was the same for extension and compression between these limits. In other words, the force required to increase the volume of a given body of liquid by a certain amount is the same as that required to decrease it by the same amount, *i.e.*, to compress it. This means that the greater the pressure required to compress a given liquid, or, in other words, the smaller its compressibility, the greater will its intrinsic pressure be. The compressibility of many liquids has been determined and is generally given as the coefficient of compressibility, *i.e.*, the reduction of unit volume by one atmosphere pressure. It is 48×10^{-6} for

water, 105×10^{-6} for ethylalcohol and 190×10^{-6} for ether. The intrinsic pressures for these liquids, calculated from Van der Waals's equation, are respectively about 11,000, 2,400 and 1,400 atmospheres, and show strikingly how the intrinsic pressure decreases as the compressibility increases.

The relations between the intrinsic pressure and other physical constants developed in the foregoing paragraphs have been found from theoretical considerations based on Laplace's theory, that is, on the assumption of cohesive forces acting over very small distances. They are of interest to us inasmuch as there is a necessary connection between intrinsic pressure and surface tension. While no numerical expression has so far been found for this, it is obvious that high intrinsic pressures must be accompanied by high surface tensions, since the surface tension is a manifestation of the same cohesive force as causes intrinsic pressure.

CHAPTER III.

WE now proceed to the consideration of a number of relations between surface tension and other physical constants which have been established largely by experiment. In view of what has been said at the conclusion of the preceding chapter, it is obviously of interest to examine the relation between surface tension and compressibility in a number of cases. We have found that a high intrinsic pressure means a low compressibility, and *vice versa*, and have concluded that surface tension goes parallel with intrinsic pressure. High surface tensions should accordingly be accompanied by low compressibilities, and this reasoning is borne out by the following table, in which the surface tensions σ are given in dynes/cm., while the compressibility coefficients β are all multiplied by 10^6 .

TABLE I.

Liquid.	σ	β
Mercury . . .	440	3.83
Water . . .	75	48
Benzene . . .	28	92
Ethyl alcohol . . .	21.6	105
Ethyl ether . . .	16	190
Acetic acid . . .	23	88
Glycerine . . .	65	52

While the general trend of the figures is as we predicted, we find that, for instance, acetic acid and glycerine exhibit considerable anomalies. These are liquids known from other evidence to be highly associated; if we exclude such associated liquids the agreement is improved, although even then the product $\sigma \cdot \beta$ is not a constant. Richards and Matthews have found that for a fair number of liquids (covering, however, only a small range of σ) the product $\sigma \cdot \beta^{\frac{1}{3}}$ is a constant.

It is only reasonable to suggest that the compressibility of a liquid may depend partly on the shape of the molecules, and that we should, therefore,

expect only a rough relation between σ and β , as we go from one liquid to another. We can eliminate this factor by keeping to the same molecules, for instance, by working with solutions of the same substance and of different concentrations. In this case the product $\sigma \cdot \beta$ is more nearly constant, but still better agreement is obtained if, instead of taking the reduction of unit volume as β , we take the change in volume for an equal number of molecules, which we may call the molar compressibility. This has been done by Röntgen and Schneider for mixtures of sulphuric acid and water, and the curves obtained for σ and the molar β are shown in Fig. 5.

The connection between surface tension and the

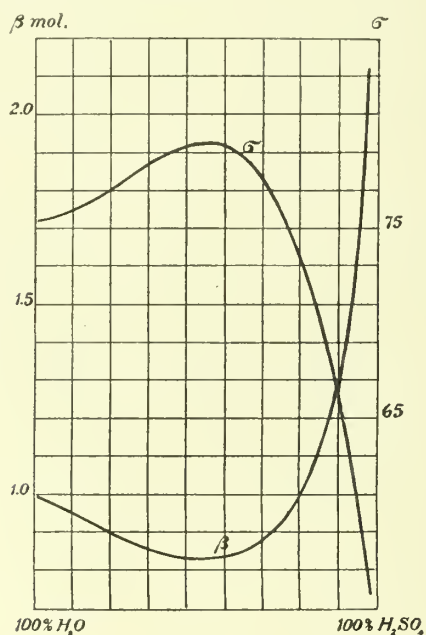


FIG. 5.

coefficient of thermal expansion has already been referred to in Chapter I. We have next to consider the relations between surface tension and vapour pressure, which are of considerable importance in a number of physical processes.

A bubble of air in a liquid is, as we know, spherical, and it is obvious that this spherical shape can only be maintained if the pressure on the inside is greater than that outside. Let P be the excess of pressure inside per unit surface, and a the radius of the sphere: the pressure tending to force the two hemispheres apart is then evidently $P \times$ area of largest circle — $P \cdot \pi a^2$. This pressure is balanced by the pull arising from surface tension, which acts round the circumference of the same circle, and is, accordingly, $2\pi a\sigma$. We have, therefore,

$$P \cdot \pi a^2 = 2\pi a\sigma \text{ or } P = \frac{2\sigma}{a}.$$

(If we consider, not a bubble submerged in liquid, but one surrounded by a thin film of the same, e.g., a soap bubble, we have to take into account the pull on both the internal and external surfaces, so that the pressure excess $P = \frac{4\sigma}{a}$.)

The excess pressure, being inversely proportional to the radius, becomes very considerable for small bubbles. As it balances the surface tension, a further rise in pressure is necessary if the bubble is to expand. If, therefore, only small bubbles of vapour are formed in a liquid, the temperature must be raised considerably above the boiling point before the bubbles expand and boiling occurs; when this happens, it does so suddenly and with violence, or, as it is usually termed, the liquid boils "by bumping." It is well-known that this can be prevented by introducing into the liquid some porous body containing air, so that the formation of large bubbles is ensured.

We have established a connection between the pressure on a liquid surface and its curvature by the formula given above. No assumption is made as to the cause of the pressure, and it remains to be seen whether we can introduce the vapour pressure into the reasoning, and thus connect this constant with the surface tension.

(To be continued.)

Errata to instalment in April number.

The last equation in the first column, p. 113, should read:—

$$\sigma_\theta = b (\theta_c - \theta - 6).$$

On p. 114, last line but one, read $\sqrt[3]{1700}$ instead of $\sqrt{1700}$.

The Chilean Nitrate Supplies.—The Official Delegate for the Chilean Government for the Eighth International Congress of Applied Chemistry has recently directed a circular letter to the American trade journals in which he contradicts the prevailing opinion that the nitrate deposits of Chili are nearly exhausted. He contends that there is a vast amount of unsurveyed nitrate ground on the Chilean pampas that is known to contain immense quantities of nitrate of soda. Furthermore, grounds already surveyed still contain enormous quantities of nitrate. There are probably, in round numbers, one billion tons of nitrate in the deposits of Chili, and without doubt, large supplies also exist on lands now but incompletely prospected. The surveyed and certified tonnage opened up at the present time ready for extracting is fully 250,000,000 tons. The probable life of the surveyed deposits is upwards of 200 years, even allowing for a steadily increasing annual rate of consumption.

Radium Deposits in British Columbia.—In a report from Vancouver, Canada, it is stated that the Chamber of Commerce of that town has appointed a committee to consider a plan for founding a public radium institute. In connection with this report it is asserted, upon the authority of physicians in that city, that indications of deposits of pitchblende have been discovered in the Columbia River valley, and analysis of the water of Sinclair Springs in British Columbia shows indications of radium deposits as if the water had passed through radium ore. It was also stated that there are indications of a probable deposit of radium ore near Fort Steel in British Columbia.

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

II. OSTWALD'S PROCESS.

THOUGH Kuhlmann, in 1830, observed that ammonia is oxidisable to nitric acid in the presence of platinum, the fact remained without commercial significance until within the last decade.

Ostwald and Brauer, however, in 1900, began an investigation into this reaction, and contrary to expectation, found it so practicable that, after thoroughly testing their process, a full-sized plant was laid down some six years ago, and with such success, that several other similar works are now in course of construction.

Taking, for the time being, the following equation as representing the course of the reaction between ammonia and oxygen,



attention must first be drawn to the fact that the oxidation is incomplete, for free nitrogen would be the final product of the complete combustion. In other words, the reaction represented above is not an *ultimate* one, but instead, one involving the formation of an *intermediate* product.

Now finely-divided platinum, the best catalyst from the point of view of nitric acid formation, was found to be an excellent catalyst for the ultimate reaction also, and the problem arose as to the differentiation of these two concurrent reactions and the suppression of free nitrogen production. Fortunately, it was discovered that the former reaction takes place very much more quickly than the latter, so that if the mixture of ammonia and air be passed at a high speed through the plug of platinum forming the catalyst, high yields of nitric acid are obtainable. A further means towards this end consists of the use of smooth platinum, partly or wholly covered with the spongy or black variety. In this way mean yields of 85% conversion of ammonia into nitric acid are stated to result.

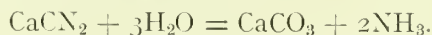
The mixture of ammonia and air found to be most advantageous in practice contains a large excess of air, having generally the proportions of one volume of ammonia to ten or more volumes of air, and such a mixture is passed over the catalyst, usually only some 1 or 2 cms. in length and maintained at a temperature exceeding 300° C., at a velocity of from 1 to 5 metres per second. In any case, the speed of circulation of the reacting gases and the length of the catalyst should be so arranged as to give a time of contact not less than $\frac{1}{100}$ second.

The difficulty of maintaining the contact temperature at anything like a constant value with such high gaseous speeds is overcome by heating the gases entering the catalyser at the expense of the hot products issuing therefrom.

The plant for this process comprises apparatus for producing ammonia gas, catalysers for the actual reaction, and condensers for the removal of the products.

Crude gas liquor furnished the source of the ammonia first employed, the liquor being brought into contact with hot air on the counter-current principle. The resulting mixture was purified by washing and passage over milk of lime to remove carbon dioxide and sulphuretted hydrogen. In some cases no purification was effected, the products of the combustion of sulphur compounds being easily removed from the nitric acid by a single operation, while those arising from nitrogen compounds, such as aniline, pyridine, and prussic acid, themselves form nitric acid.

Recently, however, the Ostwald process has been combined with that of Frank and Caro, and the ammonia is then obtained by decomposition of calcium cyanamide with steam.

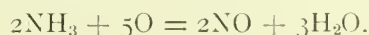


As organic materials are not found to exert any deleterious influence upon the catalyst, no purification is resorted to. The catalyst is contained in a series of stoneware cylinders, so arranged that any one of them may be put out of action without disturbing the remainder. Stoneware is essential, since no other material is available which could withstand nitric acid vapours at the high temperatures involved, these latter usually corresponding to some value between dark and red heat.

In practice, platinum appears to be the sole catalyst employed. Other members of the same group are also reactive, though not to the same extent. Ostwald states, too, that the peroxides of lead and manganese are important as catalysts, as also the oxides of silver, copper, iron, chromium, nickel and cobalt—in fact, the oxides of heavy metals in general. Matignon has shown that glucinum, tungsten and zinc possess considerable activity; whilst Frank and Caro have recently put forward thorium oxide and mixtures of this with other rare earth oxides as forming efficient catalysts.

The fact that peroxides and many oxides of bivalent metals possess catalytic activity seems to favour the idea that the oxygen of the reacting mixture enters into combination with the catalyst as a preliminary to the decomposition of the ammonia. To bring platinum into line with these is to presuppose the formation of the oxides, hypothetical and otherwise, mentioned in Chapter II.

The reaction involved is really not that represented above, but one in which nitric oxide is first produced.



The nitric oxide reacts afterwards with the excess of oxygen to produce nitrous vapours, which dissolve to nitric acid.

The resulting acid may be neutralised by more ammonia to form ammonium nitrate, or other nitrates may be produced and put on the market as such. As the company, the Nitrogen Products and Carbide Co., now engaged in working this process expect at some future time to have an annual output of nitrogen amounting nearly to the whole natural supply, the fear of any shortage of fertiliser, nitrates for explosives, etc., is now dispelled.

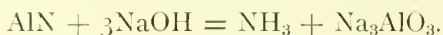
It is interesting to learn that possibly within a short period several works are to be erected in England for the manufacture of nitrates for explosives, large quantities of cyanamide being stored here for the purpose. If in the last resort the stores become depleted, it will always be possible to fall back upon the sources of ammonia first utilised, viz., the ammoniacal liquors from coke ovens, blast furnaces and gasworks.

III. SERPEK PROCESS.

Before leaving the subject of nitrogen fixation, a glance must be given at this process, on account of a recent development in the direction of the catalytic. In its latest form, the process consists simply of heating a mixture of bauxite and carbon in a current of nitrogen under pressure to about 1,800° C. in a specially-designed revolving electric furnace.



The resulting aluminium nitride is then decomposed by alkali, yielding ammonia and sodium aluminate.



Originally, aluminium carbide was employed for the absorption, and this, again, was replaced later by alumina and carbon. In both cases the absorption of nitrogen was stated by Serpek to be facilitated by the presence of a little sulphur dioxide or hydrochloric acid gas in the nitrogen. This, however, has been disproved by recent independent investigation (1912, Tucker and Read).

Moreover, the pure alumina was found to react very slightly with carbon to produce the nitride, and Serpek therefore added a trace of metal, such as iron or copper, capable of forming an alloy with aluminium, in order to increase the production. Later research has verified this result and has further demonstrated that the impure mineral alumina, bauxite, contains sufficient catalyst as impurity, chiefly of a ferruginous nature, to render its use of great advantage.

The reaction is accelerated, too, by the presence of hydrogen in the nitrogen. By combining the use of bauxite with the introduction of hydrogen into the gas, a more than cumulative effect results. In this way the reaction can be rendered practicable at 1,500° C. or so.

(To be continued.)

COPPER PRODUCTION AND PRICE IN 1913.

By JOHN B. C. KERSHAW, F.I.C.

THE annual statistical circular relating to the world's supplies of copper in 1913, prepared by Messrs. H. R. Merton & Co., of London, has just been published, and a summary of the leading figures is given below:—

I. TOTAL WORLD SUPPLIES OF COPPER IN 1913.

The aggregate output by the leading countries of the world in 1913 amounted to 986,375 tons—a decrease of a little under 20,000 tons when compared with the record output of 1,006,110 tons in 1912.

Table I. contains the figures for the world's total output of copper from the year 1900 onwards, with the relative annual increase or decrease in the production. Only once previously during this period (namely, in 1907) has a decrease in the production been recorded. Following upon the enormous increase of the year 1912, the decrease of 1913 was not unexpected.

TABLE I.—TOTAL WORLD'S OUTPUT OF COPPER, 1900—1913.

Year.	Output tons.	Increase or Decrease.
1900	479,514	7,270
1901	516,628	37,114
1902	541,295	24,667
1903	574,775	33,480
1904	644,000	69,225
1905	682,125	38,125
1906	714,100	31,975
1907	713,965	(- 135)
1908	754,180	40,215
1909	839,425	85,245
1910	864,271	24,850
1911	871,920	7,645
1912	1,006,110	134,190
1913	986,375	(- 19,735)

It indicates that supplies have once again overtaken the demand, and that producers are slackening off the activity of mining and smelting operations, in the hope of preventing any sudden collapse in price, such as that which occurred in the year 1900, and again in 1907. So far, this policy of restricting the output appears to have been moderately successful, and on December 31st the price of G.M.B. copper in London was £65 2s. 6d. per ton, as compared with an average of £68 5s. 9d. for the whole year.

At the moment of writing the tendency is for stocks to increase and for the price to fall, and the writer is of opinion that this tendency will become more pronounced as the year advances.

II. THE RELATIONSHIP BETWEEN THE WORLD'S TOTAL OUTPUT OF COPPER AND THE PRODUCTION OF THE U.S.A. MINES.

Table II. contains the figures illustrating the relationship between the output of the U.S.A. mines and that of the remaining countries of the world during the period 1900—1913.

TABLE II.—RELATIVE PRODUCTION OF COPPER BY THE MINES OF THE UNITED STATES AND THOSE OF OTHER COUNTRIES, 1900—1913.

Year.	U.S.A. Mines.		All Other Countries.	
	Tons.	Percentage.	Tons.	Percentage.
1900	263,502	55	216,012	45
1901	265,250	51	251,378	49
1902	292,870	54	248,425	46
1903	307,570	53	267,205	47
1904	365,050	56	278,950	44
1905	389,120	57	293,005	43
1906	409,650	57	304,450	43
1907	392,520	55	321,445	45
1908	423,300	56	330,880	44
1909	490,280	57	349,145	43
1910	484,935	56	370,750	44
1911	483,865	55	388,064	45
1912	554,360	55	452,750	45
1913	548,575	55	437,800	45

The proportionate output of the U.S.A. mines is seen to have remained unaltered at 55% during the past three years, 1911, 1912, 1913. Although there have been slight variations in the percentage from year to year (in the period 1900—1910), the proportion of the total supplies of copper coming from the U.S.A. mines in 1913 was the same as in the year 1900, when the aggregate output was less than one-half the present total.

TABLE III.—THE COPPER OUTPUT OF THE LEADING PRODUCING COUNTRIES (EXCLUDING UNITED STATES OF AMERICA) FOR THE PERIOD 1900—1913.

Year.	Mexico.	Japan.	Spain and Portugal.	Australasia.	Chili.	Canada.
1900	22,050	27,840	52,872	23,020	25,700	8,500
1901	30,430	27,475	53,621	30,875	30,780	18,800
1902	35,785	29,775	49,790	28,640	28,930	17,485
1903	45,315	31,360	49,790	29,000	30,930	19,320
1904	50,945	34,850	47,035	34,160	30,100	19,185
1905	64,440	35,910	44,810	33,940	29,165	20,535
1906	60,625	42,740	49,320	36,250	25,745	25,460
1907	56,565	48,935	49,675	41,250	26,685	25,615
1908	39,990	43,000	52,585	39,500	38,315	28,570
1909	56,325	47,000	52,185	34,400	35,785	24,105
1910	61,515	46,000	50,255	40,315	35,235	25,715
1911	60,905	55,000	50,930	41,840	29,595	24,930
1912	72,455	65,500	58,930	47,020	37,305	34,710
1913	51,980	72,000	53,835	46,580	39,385	34,365

III. THE COPPER OUTPUT OF THE SIX LEADING PRODUCING COUNTRIES, EXCLUDING U.S.A.

Table III. gives Messrs. H. R. Merton & Co.'s figures for the copper production of the six leading countries (excluding U.S.A.) in the years 1900—1913, and is interesting, since it shows how Mexico, Japan, Australasia and Canada have come to the front in recent years as producers of the red metal.

The falling off in the production of the Mexican mines in 1913 is due partly to the fall in price of the metal, but chiefly to the disturbed state of the country. The twelve leading copper-producing countries rank in the following order when placed according to the importance of their copper output in 1913: United States, Japan, Spain and Portugal, Mexico, Australasia, Chili, Canada, Russia, Peru, Germany, Africa, Norway.

BRONZE.¹

By JOHN DEWRANCE.

THE dictionary meaning of the word "bronze" is a compound or alloy of from 2 to 20 parts of copper to 1 of tin, to which other metallic substances are sometimes added, especially zinc. In times past, the gradually increasing additions of zinc and lead discredited the name of bronze.

In the manufacture of guns, it was found that the best results were obtained by an alloy of 9 parts of copper and 1 part of tin. This became the standard material for the manufacture of guns for many years.

To distinguish this alloy from the inferior mixtures that had previously been supplied under the name of bronze, the description gun-metal was introduced. As time went on the new name gun-metal was no more respected than the old one of bronze, and at the present time any alloy that does not come under the description of pot metal or brass is called gun metal. As guns are now universally made of steel, it seems desirable to return to the dictionary description and to call all alloys, mainly composed of copper and tin, "bronze."

To the previously mentioned alloy of 90% copper and 10% tin, it is very largely the practice to add 2% of zinc, making 88% copper, 10% tin, and 2% zinc. When tested at atmospheric temperature this alloy gives very excellent results. As a great deal of bronze is used at the temperature of high pressure steam, it becomes important to investigate its behaviour at temperatures that correspond.

The tests, the results of which are given in Figs. 1 to 4, were conducted for the author by Mr. R. H. Harry Stanger.

The heating apparatus was an air-tight tube boiler heated by gas from a ring-burner. The specimen was held in screwed jaws in the centre, both end jaws being insulated, and the boiler was also coated with asbestos.

The testing-machine being a 50-ton vertical Buckton, the weight of the apparatus is carried on the bottom headstock; the top end of the specimen was held in a plunger which enters the top of the heating apparatus through a broad guide with a sliding fit. Both ends of the apparatus are held in the headstocks by means of spherical holders, thus allowing the whole to find its true vertical axis.

As the specimen is entirely enclosed during the test, some outside means have to be adopted for ascertaining the

¹ Paper read before the Institute of Metals, March, 1914.

yield point, if any; the two ends of the heating apparatus were connected to a Wickstead hydrographic recorder, taking the base line with the beam floating immediately before applying the load after the specimen has attained the necessary temperature.

An experimental specimen was drilled with holes in different positions along the parallel length, and the bulb of a thermometer was inserted in the various positions.

This thermometer was found to agree very closely with another thermometer that recorded the temperature in the air-chamber, and it was therefore inferred that the readings of the thermometer in the air-chamber gave correct readings of the temperature of the specimen.

The percentages of elongation were given by the Wickstead recorder, and are stated throughout as the percentage on 2 ins.

The copper employed in these tests was that which is known on the market as "Best Selected," which has an average analysis as follows:—

	Per cent.
Copper	99.55
Nickel	0.01
Arsenic	0.026
Lead	0.08
Bismuth	0.004

The tin and zinc were the best commercial quality.

In the first tests made 88 parts of copper were melted in a new crucible, 2 of zinc were added as soon as the copper was melted and allowed a short time to flux the metal, 10 of tin were then added, the whole mass stirred, and the test-pieces poured at as near the same heat as could be judged by a careful moulder.

The black line on Fig. 1 shows that at atmospheric temperature the 88 copper, 10 tin, and 2 zinc alloy has a maximum stress of 16.35 tons per square inch, and the black line on diagram B shows an elongation of 11% on 2 ins.

At 400° F. it has a maximum stress of 9.5 tons, and an elongation of only 1%.

At 700° it has a maximum stress of 7 tons, and an elongation of 0.25%.

The first series of tests undertaken was that between 400° and 700° F., and the results were so unexpected that

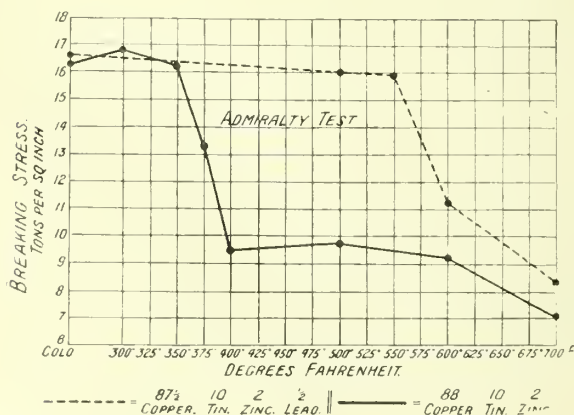


FIG. 1.

it was thought advisable to re-test some of the broken samples in the cold state, to ascertain if the fault was in the casting of the test-pieces.

For this purpose samples which had failed at 400° F. and 500° F. were turned down and suitably mounted, and

when retested at atmospheric temperature gave a breaking stress near 18 tons per square inch. Further samples in this same mixture were then prepared and tested at temperatures between atmospheric and 400° F., and the results, embodied on the diagram A, show very clearly that the metal begins to lose its strength above 350° F.

Professor Huntington, in a paper read¹ before the Institute in 1912, gives among other alloys particulars of an alloy of copper 97.673, and tin 2.408 tested cold, and at temperatures up to 870° F.

Having regard to the small proportion of tin, these results are consistent with the results given above.

In the next tests made, 87½ parts of copper were melted in a new crucible, 2 of zinc were added as soon as the copper was melted and allowed a short time to flux the metal;



FIG. 2.

10 of tin and ½ of lead were then added together, and the whole mass stirred. It will be observed that the only difference between this and the previous experiments is the addition of ½% of lead at the expense of the copper.

The dotted line in Fig. 1 shows that at the atmospheric temperature the maximum stress is 16.5 tons per square inch, and the dotted line on Fig. 2 the elongation 8%.

At 550° F. it has a maximum stress of 15.8 tons, and an elongation of 18%.

At 700° it has a maximum stress of 8.25 tons, and an elongation of 2%.

The breaking stress of 11.25 tons per square inch at 600° F. is an average. No actual sample broke at this stress. It was found that some samples tested at this temperature gave results in the region of 16 tons per square inch, and others 7 tons per square inch. From this it may be concluded that 600° is the critical temperature of this alloy.

In a paper read before the International Association for Testing Materials at the seventh Congress in New York, 1912, by J. M. Bregowsky and L. W. Spring, of the Laboratory of the Crane Company, Chicago, the results are given

¹ *Journal of the Institute of Metals*, 1912, No. 2, vol. viii. p. 131.

of tests among others of a material called U.S. Navy Gun Bronze G, which has a composition of 87.6% copper, 10.4%

necessary to inquire whether any further advantage can be gained by adding a larger proportion of lead.

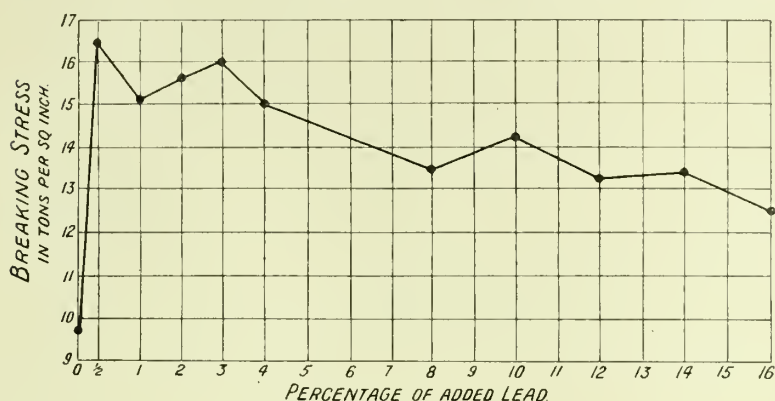


FIG. 3.—TESTED AT 500° F.

tin, 1.31% zinc, 0.39% lead—it is also stated to contain 0.11% iron; but it is probable that the iron content given is due to using a file for preparing the sample for analysis,

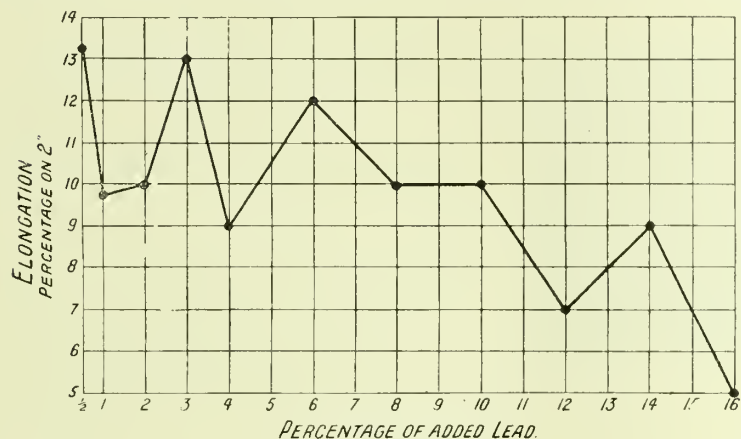


FIG. 4.—TESTED AT 500° F.

as such an alloy ought not to contain such a proportion of iron.

The chart of the test of this metal at first sight appears inconsistent with the results given in this paper; but this is due to the fact that the tests made were not sufficiently numerous. The first test appears to be at about 80° F., and gives a maximum stress of 15 tons and elongation of 9%; the second test is at 300° F., and gives a slightly increased maximum stress of 16½ tons and elongation of 9.5%. The next test is at 450° F., and gives a maximum stress of 14.75 tons and elongation of 8%. There is not another test until 600° F., at which temperature the maximum stress is given as 10 tons and the elongation as 4%.

As previously mentioned, 600° F. is the critical point, and it is unfortunate that there is such a wide gap of temperature between this test and the previous ones, as otherwise the results obtained would have been more consistent with the results given in this paper, and might have given information as to the slight difference due to that particular composition of alloy tested.

If it is accepted that ½% of lead raises the maximum stress at 500° F. from 9.75 tons to 16.5 tons, that proportion of lead becomes an essential ingredient in bronze, that is, subjected to temperatures above 350° F. It also becomes

Figs. 3 and 4 show that this is not the case; but it is surprising that with so large a proportion as 16 per cent. of lead the maximum stress at 500° F. is 12½ tons as against 9.5 tons without any lead. In making these experiments the lead was added at the expense of the copper. So the last result would be 72% copper, 10% tin, 2% zinc, 16% lead.

In making the foregoing experiments the question arose as to whether any of the results were due to the absorption of oxygen from the atmosphere by the alloy when in a molten condition. It is difficult to determine the content of oxygen in bronze, so the following experiments were conducted with best selected copper:—

EXPERIMENT NO. I.

A new 100-lb. plumbago crucible was taken. As soon as the copper was sufficiently hot an ingot was cast, and the rest of the metal was returned to the fire for an hour, when a second ingot was cast, and the same thing repeated for the third ingot.

There were thus three ingots cast from the same crucible at intervals of one hour.

On analysis the oxygen contents of the three were as follows:—

	Oxygen per cent.	Cuprous Oxide per cent.
No. 1	0.032	0.285
„ 2	0.272	2.499
„ 3	0.404	3.605

EXPERIMENT NO. II.

Two new plumbago crucibles containing 100 lbs. of B.S. copper were taken, and ¼ lb. of 10% phosphor copper was added to one, and 0.6 oz. aluminium to the other, as deoxidizers. The copper was covered with glass, so that when molten no air could come in contact with it; and three ingots were cast at intervals of one hour, as in the former experiment, the glass being left on during the casting.

Oxygen Contents on Analysis.

	Oxygen per cent.		Oxygen per cent.
Aluminium { No. 1	0.084	Phosphorus { No. 1	0.036
as „ 2	0.080	as „ 2	0.036
deoxidizer { „ 3	0.092	deoxidizer { „ 3	0.036

Both sets of results show that if the metal is kept from contact with the air when molten no oxygen is picked up; and if this precaution is not taken each melting will result in an increase in the content of oxygen, and this conclusion was accepted and acted upon when making the following experiments. The products were not analysed for oxygen on account of the previously mentioned difficulty of such analysis.

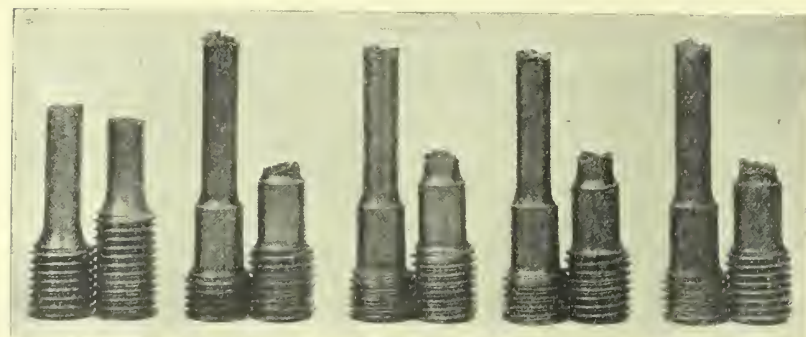
EXPERIMENT NO. III.

One new plumbago crucible containing 100 lbs. of $87\frac{1}{2}\%$ copper, 10% tin, 2% zinc, and $\frac{1}{2}\%$ lead was covered with glass to exclude the air and melted; another exactly similar charge was allowed ample opportunity to pick up oxygen by being repeatedly skimmed and left standing in the air after being taken from the fire.

Test-pieces, and a heavy flange casting with a light and thin nipple on each side, were cast from each crucible.

The flange castings were broken and examined very carefully, and both appeared as sound as it is possible to get a casting. The test-pieces gave the following results when tested cold and under heat:—

	Temperature.	Maximum load in tons per square inch.	Extension on 2 ins. per cent.
First charge covered with glass to exclude oxygen Second charge uncovered to absorb oxygen ..	Cold	15.17	9.0
	At 500° F.	13.73	10.5
	Cold	16.55	12.5
	At 500° F.	15.15	14.0



	Tested Cold.	Tested at 400° F.	Tested at 500° F.	Tested at 600° F.	Tested at 700° F.	Per cent.
Copper ..	..	..	..	..	..	88
Tin ..	..	..	..	..	..	10
Zinc ..	..	..	..	..	..	2

FIG. 5.



	Tested Cold.	Tested at 500° F.	Tested at 550° F.	Tested at 600° F.	Tested at 700° F.	Per cent.
Copper ..	..	..	..	..	..	$87\frac{1}{2}$
Tin ..	..	..	..	..	..	10
Zinc ..	..	..	..	..	..	2
Lead ..	..	..	..	..	..	$\frac{1}{2}$

FIG. 6.

EXPERIMENT NO. IV.

To complete the above results Experiment No. IV. was made, which consisted in casting a similar flange and test-pieces in "twice run" metal. The flange casting again proved sound, and the test-pieces gave the following results:

	Temperature.	Maximum load in tons per square inch.	Extension on 2 ins. per cent.
Metal twice run without any precaution to prevent absorption of oxygen	Cold	15.19	8
	At 500° F.	16.15	14

The foregoing experiments point to the conclusion that in an alloy of $87\frac{1}{2}\%$ copper, 10% tin, 2% zinc, and $\frac{1}{2}\%$ lead, no benefit results from the deoxidation of the metal, or in taking special precautions to prevent the metal absorbing oxygen.

ENGINEERING NOTES.

By R. J. DUNDERDALE, B.A. (CAMB.),
A.M.I.C.E.

Spontaneous Combustion.

Nobody who has had much to do with air compressor plants can have failed to notice the fact that quite (apparently) inexplicable explosions are prone to take place in the neighbourhood of the compressor at intervals.

Various solutions for this phenomenon have been advanced at one time or another—most of them more improbable than the explosion itself, *e.g.*, carbon monoxide, which no one would have in his compressor but for special purposes and under suitable conditions—or the ignition at a moderate temperature and compression of the lubricating oil, which is never of a kind likely to explode at the pressures and temperatures met with in even a badly-run air compressor.

In the engineering and mining journal of New York last year a report is given of Mr. Lindsay Duncan's researches to find out the cause of this curious occurrence. He attributes it to the spontaneous oxidation of carbon deposited from the lubricating oil used, in the minutest division. His view is that carbon in this condition, subjected to heat and compression continuously, may oxidize at as low a temperature as 300° as opposed to its normal oxidation point, which is about twice that temperature. His remedy is the use of a lubricating oil which does not tend to permit any of its carbon to separate out.

In the writer's opinion oxidation with flame or explosion may take place at an even lower temperature than that stated by Mr. Lindsay Duncan.

In brass-casting shops the roof of the shop commonly becomes coated with very finely-divided carbon, due to the dressing in the ingots into which the metal is poured; and it is not an unknown occurrence for this carbon to ignite after the shop has been vacated by the casters, and in a part of the shop where molten metal or flames of any sort do not occur, such as the flume of the fan.

Another case in point is the propagation of explosions through coal-dust saturated air, a number of which have occurred when, as far as was known, neither a person (always to be assumed careless and stupid) or a light was anywhere in the neighbourhood.

Applications of Liquid Air.

The March 6th issue of *Engineering* prints a short article on this subject by M. Georges Claude, who, at the beginning of his article, surveys the amount of power required to produce a litre of the substance after making allowance for the regenerative effect of the exchanges which by cooling the incoming air with the further cooled and expanded air, render the process most efficient.

He then states that under favourable conditions oxygen obtained in a modification of his process should cost as

little as 20 francs a ton. If he is correct in this, and the initial capital outlay on plant and buildings is not too great, it is quite certain that a goodly number of present oxygen works will have to "get on or get out." The first application, he mentions, is the cutting of iron and steel plates, and in conjunction with an acetylene flame this process is now firmly established. His next statement is in regard to the supply of his oxygen to the blast of large blast furnaces, and he claims that by increasing the total oxygen content of the blast from 21 (normal air) to 23%, a saving of 50 to 60 kgs. of the coke necessary for smelting a ton of iron is produced. In good practice a ton of ore will require about three times this quantity of coke to smelt it, and this very large reduction of the total coke required seems problematical, for, as with normal air, the oxidation of the coke has to supply heat for two and a half times the weight of coke consumed to the gases inert and otherwise passing through the furnace, it will be clear that there is still a pretty considerable quantity of inert gas to be heated, even when allowances are made for quicker oxidation and reduced percentage of nitrogen. His further applications are for explosives of a cellulose order, and it is claimed that while the cellulose may be brought inert to the seat of operations, it can be quickly charged with liquid oxygen and detonated with about the same results, weight for weight, as dynamite. The process also forms a means of obtaining the nitrogen for cyanamide manufacture.

REVIEWS OF BOOKS.

"SECOND STAGE PRACTICAL INORGANIC CHEMISTRY." By W. Briggs and R. W. Stewart. UNIVERSITY TUTORIAL PRESS, LTD., London, 1912. Pages 206 + xv, including Index. Chapters IX. Divided into 2 Parts. Price 2/6.

THE third edition of this useful little text-book covers both qualitative and quantitative analysis, and contains, within its 197 pages, an extraordinary amount of useful subject matter.

There can be little doubt but that this edition will meet with the same success as the preceding ones.

"INDIA-RUBBER LABORATORY PRACTICE." By W. A. Caspari. MACMILLAN & CO., LTD., London, 1914. Pages 196 + viii. Price 5/- net.

The author claims that, in this small volume, an attempt is made to give specialised practical information on the subject dealt with. In the nine chapters of this book information will be found on sampling, and the analysis, of crude and washed rubber, the machinery and apparatus used in treating it, rubber diluents, and other matters which the general chemist may desire information on. The latter chapters deal with the analysis of manufactured rubber, and with gutta-percha and balata. Although one might have possibly wished that the author had dealt with this subject in greater detail, yet there is no doubt that, so far as it goes, this work is one which will recommend itself to many con-

sulting and analytical chemists who desire a general idea of the nature of this important manufacture and its chemistry.

"PHOTO-ELECTRICITY: THE LIBERATION OF ELECTRONS BY LIGHT." By H. Stanley Allen. LONGMANS, GREEN & CO., London, 1913. Pages 221 + vii, with Index. Chapters XIV., with 15 Illustrations. Price 7/6 net.

This volume should prove an exceedingly valuable one to all those who have to consider this subject in detail. The general arrangement of the work is admirable, and the subject-matter is marshalled in a way which renders it immediately available.

The study of the electrical effects due to the influence of light is one which no chemist should ignore. Since the original observation by Hertz, in 1887, that the electrical discharge took place more readily when the gap was not illuminated by ultra-violet rays, much work has been done on this subject, generally especially when working in a high vacuum. The author deals with the early experiments, and then passes on to consider such theories of photo-electric action as have been put forward from time to time. Interesting chapters deal with photo-electric fatigue, fluorescence, and phosphorescence, and, finally, the photo-chemical actions are considered in relation to photography.

The general chemist will have no difficulty in

obtaining from this work a satisfactory idea of its development of this subject on experimental lines, and also of its extreme importance to the scientific investigator generally.

"PHOTO-CHEMISTRY." By S. E. Sheppard. LONGMANS, GREEN & Co., London, 1914. Pages 461 + ix, with Index. Chapters XI., with Illustrations and Figures. Price 12/6.

The extraordinary development of photo-chemistry in all its branches makes one welcome the appearance of this volume, for it summarises much of the work which has been done on this subject, and presents to the student a *résumé* of great value at the present juncture.

The work is divided into eleven chapters, which deal with such matters as the measurement of light quantities, the energetics of radiation, the absorption of light, dynamics of photochemical change, the genesis of light in chemical change, and organic photo-synthesis. There can be little doubt but that this volume will prove one of the most useful ones published in this series, and that it will be welcomed as an important aid to the study of this ever-widening subject.

"VISCOSITY OF LIQUIDS." By A. E. Dunstan and F. B. Thole. Monographs on Inorganic and Physical Chemistry Series. LONGMANS, GREEN & Co. London, 1914. Pages 91 + vi., including Index. Chapters IX., with 12 Illustrations. Price 3/- net.

The subject of viscosity of liquids has received great attention of recent years, for it is realised that, with a greater understanding of this phenomenon will come a corresponding advance in practice. In many industrial operations the subject under review is one of the greatest moment. Thus, for example, in the manufacture of artificial silk, where success is greatly bound up in the physical state of the solution, a general statement of results obtained up to the present will be welcomed by many, and it may be stated at once that this volume will be found a very useful one from this point of view.

The work is divided into nine chapters, the first of which is entitled the development of a working formula. The measurement of viscosity is then treated generally, both for pure liquids and also liquid mixtures. Other chapters deal with the viscosity of electrolytic solutions, and also of colloids. The question of viscosity in its relation to chemical constitution will specially interest the general chemist, as for instance, in the case of ethyl acetoacetate where variations in viscosity correspond with the gradual enolization of the ketonic form, or the effect of unsaturation on viscosity. A short chapter on some applications of viscosity in its relation to rate of reaction, the determination of transition points, and the existence of racemic compounds in the liquid state, will give the student some idea as to the use such measurements may have in the domain of research in connection with theory. The book is well worth the consideration of all those interested in this subject.

BOOKS, ETC., RECEIVED.

"Modern Steel Analysis." A Selection of Practical Methods for the Chemical Analysis of Steel, by J. A. Pickard. J. & A. Churchill, London, 1914. Pages 128 + vi., with Appendices and Index. Chapters XXI., with 10 Illustrations. Price 3/6 net.

"The Synthetic Use of Metals in Organic Chemistry," by Arthur J. Hale. J. & A. Churchill, London, 1914. Pages 169 + vi., with Appendices and Index. Chapters VI. Price 4/6 net.

"The Viscosity of Liquids," by A. E. Dunstan and F. B. Thole. Monographs on Inorganic and Physical Chemistry Series. Longmans, Green & Co., London, 1914. Pages 91 + vi., including Index. Chapters IX., with 12 Illustrations. Price 3/- net.

"Errors in Gas Analysis due to Assuming that the Molecular Volumes of All Gases are Alike," by G. A. Burrell and Frank M. Seibert. Technical Paper 54, Bureau of Mines, Washington, U.S.A., 1913. Pages 16, with 1 Illustration.

"Clean Water, and How to Get It," by Allen Hazen. Chapman and Hall, London. Pages 196 + xii. Illustrated. Price 6/6 net.

"Analyses of Coals in the United States, July 1st, 1904, to June 30th, 1910," by N. W. Lord. Part II., Descriptions of Samples. Bulletin 22, Bureau of Mines, Washington, U.S.A., 1913. Pages 1200 with Bibliography and Index.

"Mine Accident Prevention at Lake Superior Iron Mines," by D. E. Woodbridge. Technical Paper 30 Bureau of Mines, Washington, 1913.

"Safety in Tunnelling," by D. W. Burton and J. A. Davis. Miners' Circular 13, Bureau of Mines, Washington, 1913.

"Decline of Oil Wells and Suggested Methods of Prolonging Yield," by L. G. Huntley. Technical Paper 51, Bureau of Mines, Washington, 1913.

"First-Aid Instructions for Miners," by M. W. Glasgow, W. A. Raudenbush and C. O. Roberts. Miners' Circular 8, Bureau of Mines, Washington, 1913.

INSTITUTE OF CHEMISTRY.

PASS LIST: MARCH (1904) EXAMINATIONS.

Of 10 Candidates who presented themselves for the Intermediate Examination 9 passed: A. S. Carlos, B.Sc. (Lond.), C. G. Collins, (Miss) Gwen Dyer, Nat. Sci. Tripos (Cantab.), F. L. Elliott, H. S. Foster, J. J. Geake, G. Harding, J. W. Sewill, B.A. (Cantab.), and G. T. Shipston. Of 14 Candidates who presented themselves for the Final Examination, 8 passed. In the Branch of Organic Chemistry: P. K. Dutt, M.A., B.Sc. (Calcutta), J. W. Harris, B.Sc. (Lond.), and E. Mather, B.Sc. (Lond.); in the Branch of the Chemistry (and Microscopy) of Food and Drugs, Fertilisers and Feeding Stuffs, Soils and Water: P. S. Arup, C. W. McHugo, F. S. Thurston, B.Sc. (Lond.), J. A. F. Wilkinson, B.Sc. (Lond.), and F. Wright, B.Sc. (Leeds).

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, Chartered Patent Agent,
Queen Anne's Chambers, Westminster, S.W.

3707/13. E. J. BYRNE. **New or Improved Process for and Apparatus to be used in the Coagulating and for Curing of Rubber Latex and in the Anti-septicising and Drying thereof.**

3801/13. F. W. DOBSON. **Bleaching Cellulose.**
 In the bleaching of cellulose within a closed rotary vessel, air, chlorine or other suitable gas under pressure is introduced while the material is being reduced to pulp, and also while being bleached, or while being bleached only.

26370/12. W. A. HALL. **Sulphur Recovery.**

A process for the recovery in elemental and commercial form of the sulphur evolved from pyrites in water-jacket pyritic smelting furnaces and for preventing the discharge of noxious gases from the furnace consists in introducing a reducing gas in the upper level of the furnace and passing the products of combustion carrying the elemental sulphur in suspension through separating devices.

139/13. J. E. BUCHER. **Alkali Production.**

According to this process of producing alkali or alkaline earth metals, and especially sodium and potassium, a cyanogen compound of such metal is heated, preferably to a temperature between 500° and 1200° C., with a decomposing agent, such as iron, aluminium or magnesium, the agent being preferably in a finely divided state and the liberated metal preferably separated by distillation.

3194/13. A. H. LYMN. **Nitrogen Oxides or Oxyacids.**

A process of manufacturing nitrogen oxides or oxyacids consists in causing or enabling nitrogen and oxygen to combine directly with each other in actual contact with a bed of refractory substance or a porous mass of refractory substance, which is heated by the burning of a combustible gas in contact with or within the mass of refractory substance.

3554/13. G. H. BENJAMIN. **Cement Steel.**

A process for manufacturing cement steel of the type in which iron or steel is heated in the presence of a gas containing carbon and under pressure is characterised by the fact that alternating electric current is employed to heat the iron or steel and thereby increase the motion of the molecules of the iron and thus aid the combination or absorption of the carbon by the iron.

4159/13. H. W. ROBINSON. **Coal Tar Treatment.**

This process for treating tar or pitch with the object of removing therefrom the properties tending to induce pitch cancer consists in the addition to the tar or pitch at a suitable stage in the distillation or after the same of formaldehyde or other aldehydes or substances which contain or will yield suitable aldehydes.

4706/13. H. WREDE AND CORN PRODUCTS CO., LTD.
Coated Paper.

The process of coating paper consists in applying to paper an argillaceous substance with a silicate precipitated out of a starch solution.

4909/13. R. BLUMBERG. **Artificial Fuel.**

Artificial fuel is produced by employing the foliage, bark or branches of pine trees, walnut wood, cork wood, dried vine stocks or any two or more of these substances in the form of powder together with tar, clay and water. In one example, approximately 540 parts of pine foliage, 380 parts of tar and about 80 parts of clay and salt water in about equal proportions are mixed with the aid of heat so as to yield a pasty mass adapted for moulding into briquettes.

5969/13. O. KNÖFTER & CO. **Radiothorium.**

A process for the preparation of radiothorium consists in depositing it from its solutions on to a cathode by electrolysis.

6035/13. L. LILIENFELD. **Cellulose Ethers.**

A process for the manufacture and production of ethers of cellulose, its conversion products and derivatives consists in replacing hydroxyl-hydrogens of cellulose, its conversion products or derivatives by alcohol radicals.

6771/13. A. ROITZHEIM. **Improvements in or relating to Plant for the Recovery of Zinc from Zinc Ores.**

7807/13. T. TERRY. **Liquid Fuel.**

An improved liquid fuel is prepared by mixing petroleum oil and benzol, to which is added caustic soda or carbonate of soda, and either Montreal ash, potash or nitrate of soda.

7808/13. T. TERRY. **Liquid Fuel.**

An improved liquid fuel is made from a mixture of crude petroleum oil and either carbonate of soda or caustic soda, to which is added either Montreal ash, pearl ash, potash or nitrate of soda.

8500/13. R. F. EDWARDS. **Sterilising Liquids.**

A method of sterilising liquids consists in submitting such liquids to the action of ultra-violet rays whilst the liquids are in a state of fine subdivision, the treatment taking place in vacuo or in air or in an inert atmosphere.

9499/13. "MONTANIA" BRENNSTOFFVERWERTUNG
 GESELLSCHAFT m.b.H. **Improved Manufacture of Ammonia and other Bye-Products in Gas Producers.**

12800/13. A. MOISE. **Artificial Manure.**

A process for converting tanned leather waste into an artificial manure consists in the leather waste, deprived of fat if desired, being finely ground and lixiviated with water at a temperature not exceeding 50—70° C. to recover the substantial quantity of the tanning material still contained in the leather waste in a form which makes it possible to utilise it again for tanning, then opening up the residue by steam or alkali separately or together.

15165/13. FARBENFABRIKEN, VORMALS FRIEDRICH BAYER & CO. **Sulphuric Acid Anhydride.**

For the production of sulphuric acid anhydride from sulphurous acid and oxygen by the contact process, silver vanadium compounds are used as contact substances.

16031/13. A. S. FLEXER. **Nitro-Products.**

A process for the manufacture of nitro-products from a mixture of petroleum and tar with the aid of nitric acid consists in subjecting lamp petroleum in the presence of tar to the action of concentrated nitric acid and cooling.

19697/13. A. ROLLASON. **Improvements relating to the Production of Oils from Coal, Cannels and Shales.**

20593, 13. K. HOFMANN. **Activating Chlorate Solutions.**

A process for rendering chlorate solutions active consists in adding to chlorates in neutral or acid solutions osmium or its compounds, especially osmium tetroxide.

22746, 13. E. COLLETT. **Nitric Acid.**

For continuously concentrating dilute nitric acid by evaporation, the concentration is effected in steps in several evaporating apparatus from which the escaping vapours containing nitric acid are introduced into a dephlegmation apparatus.

24731, 13. O. SERPEK. **Aluminium Nitride.**

A process for the manufacture of aluminium nitride by the action of a current of nitrogen upon a mixture of carbon and alumina is characterised by the fact that the reacting materials formed by the solid pulverulent bodies

in suspension in the gases are subjected to the action of the heat produced by an exothermic chemical reaction and projected through an electric arc.

28071, 13. SOCIÉTÉ GÉNÉRALE DES NITRURES. **Nitrogen Fixation.**

A process for fixing nitrogen is characterised by the fact that the latter is passed at a comparatively low temperature over ferro-aluminium to which there have been added carbon and alumina or aluminous substances.

28682, 13. J. M. WALLWIN and F. S. SINNATT. **Purifying Producer Gas.**

Cork in small particles is used for the purpose of preventing the clogging up of the mass of material used for purifying producer, Mond and like gas.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

The Casein Industry of Denmark.

Though of comparatively recent origin, the casein industry has already attained a fair degree of importance in Denmark. The manufacture is carried on according to scientific principles, resulting in a product of great purity, which is suitable for many purposes and is largely used for making chemical food preparations, gelatine, etc. In addition to this the paper manufacturers are important consumers of better-class casein, while the inferior sorts are utilised for glue-making and other industrial purposes. The home consumption is very small, and the greater part of the Danish production is exported to Hamburg. A recent estimate of the annual output places this at about 2,000,000 kilos.

Restriction of the Importation of Volatile Oils in Roumania.

According to the N.f.H.u.I. a recent decree by the Roumanian Government placed certain restrictions on the trade in imported volatile oils and dyestuffs for flavouring and colouring food preparations. The importation of such oils, etc., by commission agents and dealers has been prohibited, and only the following firms are allowed to import and deal in them: S. A. Blank, Joho & Co.; Natan Finkelstein; Dr. A. Urbeanu in Bucharest; Dr. N. A. Racovita at Jassy, and the druggists of the country.

The Customs authorities are obliged to take samples from each consignment and to forward them to the sanitary authorities, even when the goods are consigned to the firms licensed for their importation.

Increased Prices of the Silk Dyers Combination.

Some time ago the International Union of Silk Dyers notified their intention of advancing dyeing prices, owing to the increased cost of drugs and labour, and the new list which will come into force on May 1st shows an increase of 5% in prices of blacks and colours compared with previous rates. The International Union is a federation of the Union of Zürich Silk Dyers, the Union of Basle Dyers, the Union

of German Silk Dyers, the Union of Austrian Silk Dyers, the Chambre Syndicale des Teinturiers de Lyon et St. Etienne, and the firm of Gillet et Fils, Como. The Swiss, German and Austrian unions include virtually all the silk dyers in those countries, and their standard prices apply both to the home and export markets, but the French union is a loose form of cartel, whose members only observe the standard prices of the International Union so far as foreign trade is concerned. So far it has been impossible to induce the Italian dyers to join the international organisation, and their prices are about 10% below those in the new list.

Last year German and Swiss dyers had considerable difficulties owing to strikes amongst their workpeople, and in future all contracts will contain a strike clause freeing them from liability in the event of strikes.

Potash Deposits in Spain.

In an interesting report from Spain regarding the potash deposits there, it is stated that the discovery, although no development has resulted, has caused a great deal of interest at home and abroad. With the exception of the Macar and Biader Company which it is stated is a Franco-Spanish concern, no one up till now has undertaken any investigation work and it is only geological work that has been done. This company, however, has opened up at Suria, near Barcelona, on the River Cardoner in the lower reaches, and not far from the famous deposits of rock salt of Cardoner, a pit 70 metres deep, at the bottom of which a shaft has been driven 30 metres long. This shaft cuts through a silvanite deposit (chlorate of potash) and also carnallite. Besides this opening the company has drilled a number of holes, and when the results obtained by the company became known there was a rush to make claims for land to work on. Besides the company referred to, a number of others have taken an active interest in the discovery to the extent of securing land, in case the value of the deposits should be confirmed.

Camphor Planting in the Philippines.

According to advices from Hong Kong the Bureau of Forestry of the Philippine Government, after about two

years of preliminary experiments, is preparing to start practical work all over the Philippines in planting camphor trees. The provincial Board of the Province of Ilocos Norte has made special arrangements to push the planting of camphor trees in every municipality of that district which is thought to be particularly favourable in climate. There is abundant land in various portions of the archipelago suitable for the growth of camphor trees and not suitable for other purposes.

Origin of Borax Mineral.

A scientific treatise on the origin of borax mineral has been made for the United States Geological Survey by Hoyt S. Gale, which will be of particular interest in view of the constant efforts made to increase the supply of borax. In part the paper prepared covers a study of the borate deposits in California. A review of the treatise as it has been prepared for the Survey says, among other things:—

"It is generally recognised that boric acid in considerable quantities is an original constituent in the water and gases given off with volcanic emanations. In fact, the Tuscan fumaroles, in Italy, have been an important commercial source of boric acid for a long time, and in the past, possibly even to the present time, almost all the boric acid brought into the European market has been derived from this source. There is abundant evidence of the presence of boric acid in volcanic emanations in many parts of the world. On the other hand, boron is so rare a constituent of rock-forming minerals that it forms an almost inappreciably small percentage of the earth's rock mass as a whole.

"The supposition of a desiccated saline lake to explain the origin of the colemanite had little to support it beyond rather general assumptions. The character of the deposits themselves indicates rather a vein type of formation. Other salines which would naturally be expected in desiccation deposits resulting from natural saline solutions are not found in association with colemanite. Those who have supported the desiccation theory have offered no explanation of the cause which might produce colemanite in such massive deposits as a product of water evaporation, while, on the contrary, its formation from limestone in veins by replacement of carbonic acid with boric acid is a natural hypothesis that deserves further investigation. The relations of the deposit to basalt lava flows indicate the probable origin of the boric acid at the time of the extrusion of these lavas, although it may be assumed that this acid continued to find its way into solution of the circulating ground waters long after the period of the extrusions."

Chemical Fire Extinguishers.

There can be no doubt that there exists in the public mind a very hazy idea regarding the suitability of the various kinds of fire extinguishers for different classes of work. It is not sufficiently widely recognised that many chemical extinguishers are really only suitable for use in the first stages of outbreaks. Very valuable educative work regarding the use and value of fire extinguishers has been done in the past by the British Fire Prevention Committee, who have found it desirable to formulate a standard test and model specification for portable chemical fire extinguishers, and if these are generally adopted, it is hoped that the Committee's list of fatalities resulting from the bursting of chemical extinguishers will not grow any longer.

It is suggested that these extinguishers, requiring as they do care in maintenance and handling, should not have

a capacity in excess of 3 gallons, nor should they hold less than 1 gallon, and that they should be made of copper or steel, well coated with tin on the inside, and be tested to withstand an hydraulic pressure of 350 lb. per square inch for five minutes.

The Committee's work on the subject is to be supplemented by an inquiry into the relative effects of the various chemicals and liquids generally used in such appliances, and also into the pressure generated in them under varying conditions. A special sub-committee will conduct a research dealing with non-liquid, first-aid appliances, and will investigate the various proprietary and non-proprietary materials and chemicals used in connection therewith. The work will be concluded in a few weeks' time.

German Coal Tar Colours.

According to the account of various chambers of commerce, the production of coal tar colours in Germany has proved to be somewhat less remunerative of late. The disorders in the Balkan Peninsula affected the sales, not only of the producers of Germany, but of Austria-Hungary as well, to a very appreciable extent. Added to the want of confidence on the part of the buyer, there were the tighter money conditions in various civilised countries which tended to render the traffic in goods more difficult. According to the Frankfort Chamber of Commerce report, difficulty was particularly experienced in dealing with Russia. In the United States the unsatisfactory political situation, the changes in the Customs tariffs and the various legal measures directed against the trusts affected the sale of colouring goods in North America very materially. Some German trade journals observe that in the movement taken against the trusts legitimate bounds have been exceeded, and efforts are being made to make not only American houses responsible, but their German furnishers as well, as the Americans take account of not only the combinations that have been formed in the United States, but of those which operate in Germany. Although these efforts will probably remain without the desired result, they produce a certain uneasiness all the same in the conduct of business which is ultimately felt in the turnover.

M. L.

CONSULAR REPORTS.

Carbide of Calcium Production in Brazil.

The American Consul at Rio de Janeiro reported of the erection, at the town of Palmyra, State of Minas Geraes, Brazil, of a plant for the manufacture of carbide of calcium. The production is carried on under the most advantageous conditions, as there is abundant water supply near the plant, capable of generating 4,500 H.P. The company that has inaugurated the new industry in Brazil is the Companhia Brasileira Carbureto de Calcio, and their capital amounts to about \$400,000. Most of the equipment has been furnished by the Società Italiana Westinghouse, of Vado, Italy.

Drugs and Medicines in Ceylon.

A great many people in Ceylon, in case of complaints of which they understand the nature and the general remedy, are inclined to act as their own doctors, and a great many planting estates have well-equipped dispensaries of their own, the local manager serving out remedies to their labouring staff. Special medicine cases, including

preparations chiefly in tabloid form, are frequently sold for use on estates. Such medical outfits include especially such articles as quinine bisulphate in 3 or 5 gr. tabloids, aminoniated quinine, calomel, bismuth and soda, phenacetin, soda mint, potassium chlorate, zinc sulphate, etc.

Seaweed Burning in Norway.

The utilisation of seaweed ashes in Norway dates back more than two centuries. Until 1748 it is said to have been used chiefly for the glass-blowing industry, but in that year a Scotchman came to the southwest coast and taught the Norsemen how to burn the seaweed, bringing back the ashes with him to Scotland, where they were manufactured into iodine. History would indicate that good and poor fishing years along the Norwegian coast come and go in cycles. When the poor fishing years came, the fisher-folk thought the seaweed burning was driving the fish away, hence they succeeded in placing a ban on the industry, which lasted until the present farmers forced the removal of the ban. During the past forty-five years, seaweed ashes have been exported regularly to Scotland from Stavanger, and no recent year shows exports of less than 1,500 tons.

A year ago a movement was on foot to erect an iodine factory near Stavanger, but about that time the prices of the seaweed ashes advanced sharply and the project was abandoned.

Tartaric Acid in Argentina.

In a report on the wine and fruit industry of Argentina, Consul-General Mackie states that factories are being started for the manufacture of tartaric acid, an ingredient needed in the wine industry, and the cream of tartar derived from the dregs, grape residue, and wine lees is developing into a profitable business. Such an industry should place into local circulation the sum of \$1,000,000, that at present leaves the country to pay for the imported product.

Saccharine Smuggling in Switzerland.

Saccharine smuggling in Switzerland will be more energetically prosecuted in the future. The centre of smuggling is Zurich, where more than 1,000 persons are said to live on this profitable occupation. Whereas so far no strict measures have been taken by the Government to stop smuggling, it has been decided to institute strict inquiries into the occupation of foreigners living at Zurich, and if they are unable to give a satisfactory account of their incomes, etc., they will be allowed a fortnight for quitting the country.

MARKET REPORTS.

LONDON.—The result of the foreign trade in chemicals during the past month does not compare favourably with the corresponding period of last year, as the value of the exports in chemicals, drugs, and colours showed a decrease of £50,567. The chief decline took place in the exports of coal products, other than dyes, the value of which fell from £258,292 in March, 1913, to £208,728 last month. A further notable decrease occurred in the exports of copper sulphate and of soda compounds. On the other hand, imports of chemicals and allied products rose in value from £1,052,052 in March, 1913, to £1,160,080, thus increasing by £108,630. The home trade in chemicals has occasionally shown signs of improvement, although during the last few weeks business

was influenced by the holidays which were generally extended on account of the fine weather. The demand from the textile manufacturers has not yet improved, but there is no further restriction to be chronicled which in itself is something to be thankful for, considering the uncertain position of the cotton industry and the much-discussed attempt to organise short time in the cotton mills.

The market for fertilisers has been very disappointing to producers and sellers. Nitrate of soda developed some weakness owing to the reports of lower prices on the Continent. The probable consequence of the reduced Hamburg quotations will be larger supplies at Liverpool, making it more difficult still to keep prices up. The present quotation for ordinary quality is £10 15s. and for refined £11. Sulphate of ammonia has been unfavourably influenced by the coal strike in Yorkshire which caused producers to hold off the market. The general position of this article is rather worse than better, as the temporary decline in production on account of the disturbances in the coal industry will quickly be followed by a normal output. In order to fully absorb all available supplies the export demand will have to show more life than it has done so far during the present season. The quotation for grey, 25 % sulphate, prompt delivery, is £11 17s. 6d.—£12. The business in tar products has suffered from the uncertainty created by the Yorkshire coal strike, and the transactions have been very limited. Pitch producers are hoping for a good demand for road-making purposes on account of the dusty and dry weather during the last fortnight or so, but the ordinary trade inquiry is extremely dull. Under the circumstances the quotations are quite nominal at 36s.—38s. In view of the present restriction of production and the probability of an active demand for road-making any fluctuation of prices will most likely favour producers, who are none too anxious to sell at the present rates. Benzol benefits by the increased activity in motor traffic and the home demand on this account is visibly growing. 50% Benzol for prompt delivery is held at 11½d., while 50—90% quality is quoted at 1s. 1d.—1s. 2d. per gallon. No improvement can be recorded in carbolic acid. Crude 60's remains at 1s. 0½d. per gallon and crystals at 3¾d. per lb. Crude naphthalene is in good demand at firm prices, e.g., 60s.—90s. for good to fine qualities. The inquiry for creosote is well maintained. Acetic acid seems to have reached its lowest limit, and producers are not inclined to accept offers under £30 per ton for 99—100% glacial. Citric acid is also tending upwards. Prompt delivery is difficult to obtain and the buyers have to pay 1d. per lb. more than for June—July delivery. English citric acid is quoted at 2s. 3d. and foreign at 2s. 2½d.

MANCHESTER.—The markets have been affected by the holiday spirit and the disturbing influence of the coal strike. The foreign demand has kept up fairly well but the home trade reflected the uncertainty created by the troubles in the coal industry. Heavy chemicals are quiet and steady, though there is a firmer tendency in some sections of the market. Citric acid is scarce and firm. Cream of tartar favours sellers at 92s.—94s. per cwt. Bi-carbonate of soda is steady at 70s.—100s. per ton, according to quality. Powdered arsenic has receded a little, the present quotation being £13 15s.

LIVERPOOL.—The demand for chemicals has been fairly regular. Phosphate of soda attracted a little more attention than of late and the price has risen to £10 per ton. Bicarbonate of soda has also been in fair request at £5 10s. per ton, in kegs for export, f.o.b., and at £5 f.o.r. at works. The outbreak of the foot-and-mouth disease in cattle in several parts of the country has stimulated the business in disin-

fectants. In addition to lime, which is largely used by the railway companies, liquid disinfectants, such as carbolic acid and chloride of lime are freely used. The spot quotation for the latter is £5 7s. 6d.—£5 15s. per ton, in 6 to 8 cwt. soft-wood casks, f.o.r., at works.

NEWCASTLE-ON-TYNE.—Sulphate of ammonia is dull and lifeless and producers are ready to meet buyers, although the nominal quotation remains at £12 7s. 6d. per ton, f.o.b. Tyne. Bleaching powder is well maintained. Sulphate of copper tends in a downward direction owing to the weaker condition of the raw material.

Metal Markets.

LONDON.—The position of the copper market has been quite upset by the outbreak of hostilities between the United States and Mexico. In recent weeks the more active buying on home and American account as well as the better statistical position of the metal had created renewed confidence, and it seemed as if a period of undisturbed activity could be expected, but the events of the last few days have naturally upset all calculations. Standard copper closes at £64 2s. 6d. cash, and at £64 7s. 6d.—£64 2s. 6d. three months. Manufactured copper has been quiet and rather easier. Tin developed pronounced weakness on account of over-supply of Nigerian and Bolivian metal and the turn of affairs in America. The latter threaten to diminish the heavy consumption for engineering purposes, the extent of which has materially helped to prevent a strong downward movement in recent weeks. The closing quotation for cash tin was £161 15s.—£161 10s., and for three months £163 15s. The Welsh tinplate trade has not improved. Lead has remained rather dull but although there is quite an accumulation of arrivals the tone has been steady, as consumers seem to be short of material. English lead is firmly held at £18 10s., while foreign lead for May delivery sold at £18. Manufactured lead is very firm. Spelter for near delivery has experienced better demand. It is expected that the Syndicate will decide to cut down the output from the end of this month when the new working arrangements of the Convention come into force. The prices range from £21 12s. 6d.—£21 17s. 6d. according to position.

FINANCIAL ITEMS.

The annual report of Messrs. Mappin & Webb shows a net profit of £54,250, which is, however, £4,650 less than that earned in 1912. 10% is paid on the ordinary shares as before, £20,000 is carried to special reserves, goodwill, etc., and £16,843 has been carried forward.

Messrs. Joseph Watson and Sons, Ltd., soap manufacturers, of Leeds, show a profit for the last financial year of £103,999, as compared with £84,114 for 1912—1913. A dividend of 7½% on the ordinary shares will be paid, and £1,000 placed to the pension fund.

Recklinghausen.—The Annual Report of the Gewerkschaft König Ludwig for 1913 states, amongst other things, that in consequence of the erection of large plants for ammonia production, the output has been much increased while the imports have diminished. Though the home consumption is now larger than ever before, its growth has not quite corresponded with the increased production, which caused the accumulation of large stocks. Since February of this year the demand has, however, revived very satisfactorily and thus helped to clear the stocks. In order to stimulate consumption the producers decided last December to make

a general price reduction. Benzol was very well inquired for all the year round, and the sales took place at the same prices as last year. All tar products went off very well at favourable rates. The output of the three coke-plants was as follows: 19,145 tons (19,126) tar; 6,911 tons (6,878) sulphate of ammonia; 4,113 tons (3,879) light oils; 358 tons (254) naphthalene. The consumption of sulphuric acid (60%) amounted to 6,963 tons. The tar distilleries produced 38,026 tons (30,618) pitch; 11,957 tons (16,356) heavy oils; 993 tons (2,266) naphthalene, and 314 tons (510) anthracene.

Berlin.—Chemische Fabrik auf Aktien (vorm. E. Schering) made gross profits of 1,868,499 marks (1,791,745), and will pay a dividend of 15% (13%) on their common stock, and 4½% on their preference shares.

Berlin.—The Chemische Werke Lubczinski Co. A. G., a company incorporated last year with the aid of the Dresdner Bank, made a gross profit for the first year of 1,000,560 marks. The net profits amount to 410,891 marks, of which sum 225,000 marks will be absorbed by a dividend of 15%. The reserve fund will receive, in addition to the statutory sum of 20,544 marks, an extra sum of 79,455 marks. The prospects for the current year are considered very favourable.

Aussig.—The Oesterreichische Verein für chem. und metall. Produktion at Aussig have again declared a dividend of 16%.

Berlin.—The Oberschlesische Kokswerke & Chemische Fabriken A. G. had a very satisfactory year. Their gross profits amounted to 4,661,745 marks (4,316,854), while the net profits reached 3,618,524 marks (3,242,529), enabling the directors to pay a dividend of 17% (15%). The annual report states that the trade in sulphate of ammonia was good during the first half of the season, but later on the appearance of synthetic ammonia, offered by the Badische Anilin & Soda Fabriken, caused a complete slump, as consumers wanted to await events. After the agreement between the Badische concern and the German Ammonia Sales Association had been arrived at an active demand ensued. Benzol experienced a strong inquiry for motor purposes, and several new purposes for this product were discovered. The prospects are considered quite promising.

The Syndicat International de "Permutit" at Antwerp have decided to cease their activity, since the object of the corporation—e.g., the sale of the patent rights in all countries—has been attained, and there is no further necessity to operate in this direction. The German Permutit company works quite successfully. The prospects for the second year of their existence are favourable, and another good dividend seems likely. The last one amounted to 10%.

Budapest.—Klotilde A. G. für chemische Industrie made a net profit of 1,366,121 kr. for 1913-14. The dividend will be 8%, the same as last year.

The Norddeutsche Sprengstoff Werke A. G. is the title of a new company which has been registered at Hamburg. Their capital is 1,000,000 marks, and their object is the manufacture of explosives and chemicals. Adolf Lipken, of Vallendar on Rhine, has been elected President. The incorporators have taken up all the shares, which are of a value of 1,000 marks each.

Tubize (Belgium).—The gross profits of the Fabrique de Soie Artificielle de Tubize for 1913 amounted to 2,163,907 francs (3,181,936), while the net profits were 1,088,902 francs (1,374,307). The dividend will be 12½ francs on the preference shares of 50 francs each, and 10 francs on the common stock. The directors consider this result very satisfactory in consideration of the critical times the

business world has experienced. The demand for artificial silk has experienced a great revival since August, 1913, and the whole production for the current year has been already sold.

Elberfeld.—The Vereinigte Glanzstoff Fabriken A. G. state in their annual report that the sales of artificial silk were unfavourably affected by an adverse fashion. In spite of this, the company made a net profit of 5,743,597 marks (4,078,155). Their dividend will be 36% (40%), and a sum of 1,023,512 marks is being carried forward, while 1,450,000 marks are added to the reserve fund. A further sum of 670,085 marks (654,723) will be divided as a bonus.

NEW COMPANIES.

BIRKETT CHEMICAL Co., LTD.—Capital: £10,000; 9,000 7% cumulative part preferred of £1 each, and 10,000 ordinary of 2s. each. Object: To carry on the business of manufacturers of and dealers in disinfectants, manures, lubricating oils, grease, etc. Registered office: 13, Aston Road, North Birmingham.

DUNMANUS BAY BARYTES Co., LTD.—Capital, £30,000 in £1 shares. Object: To adopt an agreement with Dereenalomane Barytes Mine, Ltd., and J. D. Henderson, the liquidator thereof, to carry on the business of miners, smelters, importers and exporters of or dealers in barytes, lead, or other minerals, etc. Registered office: 24, Finsbury Square, E.C.

NORTHERN SYNTHOL MOTOR SPIRIT Co., LTD.—Capital, £50,000 in £1 shares. Object: To carry on the business of manufacturers and refiners of and dealers in oils, hydro-carbons and spirit, natural gas, asphalt, ozokerite, coal, shale, tar, paraffin, and similar substances and products thereof, and substances adapted for use with internal combustion engines, etc., and to adopt an agreement (the parties to which are not named) for the acquisition of certain property. Registered office: Borough Road, Weaste, Manchester.

HARTLEY AND PARTNERS, LTD.—Capital, £20,000 in £1 shares. Object: To carry on the business of manufacturers of and dealers in oils and all kinds of unguents and ingredients, manufacturing, and general chemists, etc., and to adopt an agreement with H. Hartley.

HYDRONYL SYNDICATE, LTD.—Capital, £7,000 in £1 shares. Object: To carry on the business of manufacturers of and dealers in chemical, industrial and other substances and to adopt an agreement with R. Lessing. Registered office: 140, Leadenhall Street, E.C.

WILLIAM DALTON & Co., LTD.—Capital, £1,000 in £1 shares. Object: To carry on the business of chemists, druggists, drysalts, oil and colourmen, etc., and to adopt an agreement with W. Dalton. Registered office: 14, Hill's Place, Oxford Street, W.

MINERALS AND METALS, LTD.—Capital, £10,000 in £1 shares. Object: To take over the business carried on by Sulphates, Ltd., to establish works for obtaining sulphate of copper and other substances, etc. Private company.

ELECTRO-BLEACH AND BY-PRODUCTS, LTD.—Capital, £180,000 in 120,000 7% participating preference shares of £1 each and 120,000 ordinary shares of 10s. each. Objects: To carry on the business of manufacturers of and dealers in alkali chlorine bleaching powder, bleaching liquor, caustic soda, soda compounds, salt, lime, and other chemical substances by any electrolytic or other form of plant or

process, distillers, refiners and vendors of such substances and all residual and other products and by-products of brine, lime, chlorine, and chemicals, gases or liquids, etc., and to adopt an agreement with the Financial Engineering and Chemical Co., Ltd., for the acquisition of certain properties.

F. E. ATTEAUX & Co., INCORPORATED IN BOSTON, U.S.A.—Capital, \$250,000. Object: To manufacture dye-stuffs and chemicals. Incorporators: F. E. Atteaux, Brookline; C. E. Peaks, Weston.

RADIUM PRODUCTS CORPORATION IN MANHATTAN, U.S.A.—Capital, \$100,000. Object: To carry on the business of general importers of radio-active ores and products.

SHARE LIST.

Name of Company.	April 24th.	March 24th.
Alby United Carbide	1 ¹ / ₂	1 ¹ / ₂
Ditto. Pref.	1 ¹ / ₂	1 ¹ / ₂
Associated Portland Cement. (10)	5 ¹ / ₂	5 ¹ / ₂
Ditto. Pref. (10)	8 ¹ / ₂	8 ¹ / ₂
Babcock-Wilcox. Ord.	3 ¹ / ₂	3 ¹ / ₂
Ditto. Pref.	1 ¹ / ₂	1 ¹ / ₂
Bell's United Asbestos	1 ¹ / ₂	1 ¹ / ₂
Belachers' Association. Ord. ..	2 ¹ / ₂	2 ¹ / ₂
Ditto. Pref.	1 ¹ / ₂	1 ¹ / ₂
Borax Consolidated. Pfd. (5) ..	5 ¹ / ₂	5 ¹ / ₂
Ditto. Defd.	2	2
Ditto. Pref. (10)	11 ¹ / ₂	11 ¹ / ₂
Bradford Dyers	1 ¹ / ₂	1 ¹ / ₂
Ditto. Pref.	1 ¹ / ₂	1 ¹ / ₂
British Oil and Cake. Ord. ..	4 ¹ / ₂	4 ¹ / ₂
Brunner Mond. Ord.	15	15
Ditto. 7% Pref. (10)	15 ¹ / ₂	15 ¹ / ₂
Bryant and May. Pref.	2 ¹ / ₂	2 ¹ / ₂
Calico Printers	1 ¹ / ₂	1 ¹ / ₂
Ditto. Pref.	1 ¹ / ₂	1 ¹ / ₂
Castner Kellner	2 ¹ / ₂	2 ¹ / ₂
Commercial Salt. (2/-)	7 ¹ / ₂	7 ¹ / ₂
Crossley & Sons. (2)	1 ¹ / ₂	1 ¹ / ₂
Ditto. 5% Pref.	4 ¹ / ₂	4 ¹ / ₂
Eastman Kodak. (\$100)	570	500
Eley Brothers	1 ¹ / ₂	1 ¹ / ₂
Fraser and Chalmers. (£3)	1 ¹ / ₂	1 ¹ / ₂
Gas Light and Coke. (S.)	101	100
Ditto. 4% Pref. (S)	96	95
Greenwich Lino. (1)	3 ¹ / ₂	3 ¹ / ₂
Harrison and Crossfield. Pref. ..	1 ¹ / ₂	1 ¹ / ₂
Imperial Continental. (S)	171	172
Ditto. 3 ¹ / ₂ % Debenture (S) ..	84	83 ¹ / ₂
India Rubber Co. (10)	103	103
International Salt	3/-	3/6
Ditto. Pref. (5/6 pd.)	1 ¹ / ₂	1 ¹ / ₂
Lever Brothers. 1st Pref. (10) ..	11 ¹ / ₂	11 ¹ / ₂
Lister & Co. Ord.	1 ¹ / ₂	1 ¹ / ₂
Mappin & Webb. Ord.	1 ¹ / ₂	1 ¹ / ₂
Neuch'tel' Asphalt.	9 ¹ / ₂	9 ¹ / ₂
Nobel Dynamite. (10)	103	103
Ditto. Bearer (10)	17	17 ¹ / ₂
Ditto. 5% Pref. (10)	11	11
Pears, A. and F. Ord.	1 ¹ / ₂	1 ¹ / ₂
Ditto. 6% Pref. (10)	12 ¹ / ₂	12 ¹ / ₂
Price's Candle. (16)	36 ¹ / ₂	36 ¹ / ₂
Rosario (5)	8 ¹ / ₂	9 ¹ / ₂
Salt Union. (4)	1 ¹ / ₂	1 ¹ / ₂
South Metropolitan 4% Standard (S)	109	109 ¹ / ₂
Ditto. 3% Debenture (S)	73	73
United Alkali. (10)	1 ¹ / ₂	1 ¹ / ₂
Ditto. Pref. (10)	6 ¹ / ₂	6 ¹ / ₂
Val de Travers	1 ¹ / ₂	1 ¹ / ₂



THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY W. P. DREAPER, F.I.C.

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

VOL. III. No. 6.

JUNE, 1914.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
" " Abroad 8s. " "

Value Received.

Under the title of "Sweating the Scientist" a recent article has been published in *Science Progress*. It is chiefly concerned with the recital of the emoluments received by scientific workers, and the data collected is said to suggest that the rate of remuneration given for such services throughout the British Empire is quite inadequate.

It is rightly pointed out that the remuneration paid to professors, even in the highest posts, rarely exceeds £1,000 per annum, and that in nearly all cases pensions are contributory. This statement agrees with that made by Sir W. Tilden before the Institute of Chemistry. Such salaries compare very badly with those paid in the Army and Navy, which reach to £4,000—£5,000, and probably more when certain allowances are added. It must be remembered, however, and this point has not been considered by the writer of this article, that, if the professor is inclined to the industrial side of his science, the fees he may receive for consulting work in this direction may be considerable, especially in the engineering profession.

It is pointed out that this condition of under-recognition of the academic side of science also applies to medicine. When it is compared with the clinical side, remuneration "seldom, if ever, exceeding £1,000 a year," while in the latter case it is well known to run to "many times that amount, especially in surgery." It is claimed that, "compared with the law, science stands nowhere at all in payment or position." The disparity is even greater in "business, and the enormous fortunes made in innumerable directions by manufacturers, retail and wholesale traders, financiers, and so on, would, in single cases, cover the whole funds allotted to science throughout the British Empire." It is, therefore, argued that the elementary principle that good pay should be given for good work is not considered to apply in the case of scientific workers; and this in spite of the fact that the work of scientific investigators is of greater advantage to the world at large than any other line of effort. "Science has become our premier industry, and governs every other industry, just as the architect governs that of the individual bricklayer."

If, it is argued, that the scale of payment for science is purely a question of supply and demand, says this journal, the same condition governs the case of the sweated industries of all kinds. "In the latter case the employer exploits the necessities of a crowded and poor population in order that he may have his work done at the cheapest rate. As regards science, however, the employer is the public itself, and the sweated labourer is the highest type of intellect in the country."

"Originality and success in research do not receive their due place in selection for appointments. The best paid posts are seldom given for the best work done, but rather for qualities which are of little account—popularity, eloquence, text-book knowledge, private influence, and skill in the art of time service."

Twenty millions are spent annually, says this writer, by the Board of Education, and yet the recipients still exhibit a callous indifference to the work of those who are concerned with the things which really matter in their physical life.

The position as it exists to-day, even when the statements of this writer are fully discounted, is certainly of the order which demands reflection.

IRON AND STEEL INSTITUTE MEETING.

By D. A. LOUIS, F.I.C.

FERRO-METALLURGY attracted considerable attention last month owing to the Spring Meeting of the Iron and Steel Institute being held at the Institution of Civil Engineers, Westminster, on May 7th and 8th. There are some who contend that ferro-metallurgy is not a chemical industry, and as this attitude has proved calamitous to many an enterprise, we commend to such authorities the careful contemplation of the character of the papers presented at this meeting of the Iron and Steel Institute and the status of the twenty-two authors. Of these latter, with the exception of three, all were in some degree chemists. The President himself, Dr. Adolphe Greiner, of Seraing, Belgium, started his career as works chemist, and his address was redolent of the laboratory. This industry is, in fact, one of the stupendous and magnificent branches of chemical industry, not the least striking features of which are the extraordinary contrasts encountered; the enormous

and ponderous masses dealt with, and, at temperatures ranging from below the ordinary to the highest obtainable—real cyclopean conditions; yet the quality of the product is absolutely dependent on minutest chemical differences and infinitesimally intimate molecular movements, or truly microscopic factors demanding exact adjustment of chemical composition, temperature and treatment, to control which some of the most refined tests are in constant requisition. True, this industry demands the application of much splendid and skilled engineering work, but, after all, this is only required to provide ways and means for carrying out the chemical processes in a proper manner and on an adequate scale. All these points were touched on and elucidated at the meeting under notice.

The most strikingly modern and practical paper was that by Dr. F. Schuster, of Witkowitz, on "The Talbot Process in comparison with other Open-Hearth Refining Processes." He magnanimously disclosed results of searching and costly practical experiments made at the Witkowitz works, and included much valuable practical detail. At that works they are required to produce a multiplicity of products of any desired quality of steel from a restricted selection of raw materials and to carry out individual changes in quick succession. To solve this problem investigations were undertaken at home and abroad, and, as a result, a series of furnaces were installed, with mechanical appliances driven by electric energy, utilising *waste gases*, replacing as far as possible hand labour. The installation included a mixer, three 50 to 60-ton fixed open-hearth furnaces, a 60-ton Wellman tilting furnace, a 200-ton tilting Talbot furnace; each to produce in large quantities, steel of the precise composition required. There were also some auxiliary electric furnaces for making smaller quantities of special steels. Even the ladles, those for transferring the pig from the blast-furnace to the mixer, as well as those conveying the molten steel to the moulds, were utilised to effect some desired chemical change; whilst the mixer was so controlled as to always supply a quantity of iron of uniform chemical character up to 500 tons a day. Under precise chemical control all the furnaces were found to work well, but the Talbot furnace showed to such conspicuous advantage that the author described it as the open-hearth furnace of the future. Mr. Talbot was very pleased, but regretted this paper had not appeared before his patent rights were so near their end. This paper so strikingly illustrated the happy combination of engineering and chemistry in ferro-metallurgy that we have mentioned it before the Presidential address. The President is general director of the famous Cockerill works, and is noted for his vast and varied knowledge, but for the purposes of the address, he drew upon one section only—by-products. He asserted that there is now, so to speak, hardly a single works of importance that does not consist of several departments closely linked together in interest and subject to a common control. Coke-ovens, blast-furnaces, steelworks, with converters or open-hearth furnaces, rolling-mills, and forges, constitute a harmonious whole to which all the parts contribute their co-operation in order to effect the greatest possible economy in working.

And this economy could only be achieved by the proper utilisation of the by-products consistent with their chemical characters, such as the production of tar, ammonium sulphate and benzol from gases; from dust and slags:—cement, bricks, ballast, agglomerates, etc. Moreover, great profits accrue from attention to these matters. It was shown that the phosphatic slag produced in 1913 was worth £8,000,000; whilst the proper utilisation of the *waste*

gases and their products would yield a profit of 8s. 11d. on every ton of pig-iron produced; this does not, however, exhaust the possibilities of by-product utilisation. But in a paper on "The Production of Steel direct from Ore," Messrs. Ernest Humbert and Axel Hethey described the achievement of this feat in a Héroult electric furnace, and for a moment led some to regard all ordinary furnaces and their by-products as doomed, but if such be the case, the speakers at the meeting did not anticipate its happening for a long while yet. Dust in the *waste gases* is detrimental to their use in stoves, engines or under boilers, and Mr. Fritz Müller (Biebach) described an ingenious dry-cleaning process. There were advocates of dry cleaning, and others that favoured wet methods; but Mr. Walter Dixon, of Glasgow, struck the right key when he mentioned dust prevention, and what is more, promised a paper on it.

"Hardening" received attention at many hands; Mr. Heathcote, of Coventry, had many useful suggestions for controlling case-hardening practice and testing the hardness of the case; as a case-hardening composition, he advocated wood-charcoal impregnated with soda-ash and carefully sifted to proper sized grains. Mr. Greenwood had noticed decarburisation and softening "during the hardening of steel dies," in spite of the conditions being those for hardening. Mr. Andrew M'Cance, in "A Contribution to the Theory of Hardening," described many excellent experiments referring to the variations in the properties of steel of different carbon content with the temperature of quenching, the properties comprised hardness, electrical resistance, density and specific volume, magnetism, resonance. He expressed some excellent views on the theory of quenching, practically investigated, too; he was of opinion that β -iron is not a separate allotropic condition of iron, and that hardness might be attributed to the presence of carbon and interstrain. Professor C. A. Edwards and H. C. H. Carpenter, in a discourse on hardening, favoured Dr. Beilby's amorphous form theory to account for hardness, this form being produced at slip surfaces where twinning occurred. They regarded martensite and austenite as twins of the same constituent, but for these substances Dr. Desch claimed a chemical difference. The discussion generally showed that considerable difference of opinion still exists on these points. Mr. C. Chappell (Aachen) dealt with "the re-crystallisation of deformed iron," and showed some interesting relationships between the degree of deformation and the coarseness and fineness of the re-crystallisation in annealing. Sir R. A. Hadfield and Professor Hopkinson showed that certain manganese steels develop magnetism persisting within certain ranges of temperature. Professor Carl Benedicks, of Stockholm, gave the result of some excellent "experiments on allotropy of iron; behaviour of ferro-magnetic mixtures; dilatation of pure iron." Professor J. O. Arnold and Mr. Bolsover showed that sulphides may exist in steel ingots as filmy reticulations or as segregated droplets, aluminium favouring the former. Molybdenum was shown by Dr. J. Newton Friend and Mr. C. W. Marshall, under some circumstances, to render steel more corrodible, but not under others. Dr. Walter Rosenhain and Mr. J. L. Haughton described how mild steel might be coated with a film of copper and its microstructure rendered plainly visible. Mr. G. Misson, of Seraing, showed how arsenious anhydride might be used for the colorimetric estimation of sulphur in pig iron and steels. Mr. Sidney A. Houghton (Glasgow), explained the "failures of heavy boiler shell plates," and Mr. Aloke Bose, of Bengal, described an iron works in India. Finally, be it noted, the Institute gave a tribute to chemistry in awarding the Bessemer gold medal to Mr. Edward Riley.

SOME EXPERIMENTAL METHODS AND THEIR POSSIBLE EXTENSION.

By ALFRED W. STEWART, D.Sc.

In recent decades there has been a marked tendency on the part of chemists to adapt to their particular field many instruments which have been devised for investigations in other branches of science. Thus the polarimeter, the refractometer and the polariscope have found their uses in chemistry; and it seems not improbable that in the future an even wider employment of these instruments may be expected. New applications of the older instruments are being brought into practice, and some of the old problems are being attacked by the aid of fresh experimental technique; but, at the same time, it is sometimes found that methods which appear capable of wider extension are allowed to fall into neglect. Two or three examples will serve to recall some of the apparatus which might be brought to bear upon certain problems which at present are handled by other methods.

The centrifuge is an instrument which up to the present has been much more frequently employed by pathologists and biochemists than in ordinary chemical laboratories; but the way is already open for a much wider application of centrifugal methods in ordinary analytical work. Friedenthal (*Ber.*, 1911, 44, 904) suggested that, by taking advantage of the difference in specific gravity between two components of a mixture (*e.g.*, a mixed precipitate) it would be a comparatively simple matter to separate one of the constituents from the other. In order to do this, it is only necessary to suspend the solids in a liquid whose density lies between those of the two precipitates, and then to centrifugalise the mixture for a short time. The heavier substance accumulates below the liquid, while the lighter one is left on the surface; and this way the two solids can be separated. This method also furnishes the chemist with a rapid means of getting rid of slight traces of impurity. For example, assume that a specimen of sodium chloride is contaminated with potassium chloride. The density of the former body is 2.10, while that of the latter is 1.99. A mixture of bromoform and xylene can be prepared whose density lies about 2.04; so that the sodium chloride will be lighter than the liquid, while the potassium salt is heavier than the bromoform-xylene mixture. The solids are placed in the centrifuge receiver, the liquid is added, and the machine allowed to run for a short period. At the end of this time, all the potassium chloride will be found floating on the top of the liquid while the sodium chloride will have sunk to the bottom; and in this way the impurity may be separated with great ease and rapidity from the main bulk of the sodium chloride. The application of such methods to quantitative operations is obvious, though the apparatus is somewhat more complicated.

In the detection of small quantities of precipitates the nephelometer has been brought into practice, and Kober (*J. Biol. Chem.*, 13, 485; *J. Amer. Chem. Soc.*, 1913, 35, 290, 1585) has devised a quantitative method for the determination of the amount of precipitate in suspension by means of a photometric apparatus. The advantage of the new method lies in its rapidity; for while with the usual technique the estimation of casein, globulin and albumin in a milk sample may require two or three days, with the nephelometer the same sample can be dealt with in about half an hour. The extension of nephelometric methods to other branches of analytical work should lead to a great increase in the speediness with which results are obtained.

In this connection it might be suggested that there is a field open for the tintometer in the case of rough estimations of coloured precipitates. If the coloured precipitate were shaken up with suspensions of a white solid of various strengths, it should be fairly simple to bring the tint to a standard type, and in this way to make a fair guess at the amount of coloured precipitate present.

Another method of detecting traces of certain impurities was suggested by Andrews (*Brit. Assoc. Reports*, 1852, p. 33); and, though it seems to have fallen into neglect up to the present, it appears to have the germs of wider applications in it. Suppose that we have a specimen of a potassium salt which contains very small traces of a sodium salt in the form of impurity. If this sodium salt be present in very small quantity, it might be difficult to detect it except by means of the spectroscope. If the impure salt be converted into the chloroplatinate and placed on a microscope slide it would be extremely difficult to prove the presence of two sets of crystals by inspection; but if a petrological microscope be used, it is found that under polarised light the potassium chloroplatinate has no pleochroism, whilst the sodium chloroplatinate crystals show a brilliant play of colour. In this way, according to Andrews, it is possible to detect $\frac{1}{1300000}$ gm. of soda. The extension of this method also is fairly obvious.

The dilatometer is another instrument which seems to be capable of a much wider application than it has hitherto found. Wright (*Proc. Chem. Soc.*, 1913, 29, 280) has shown that by a slight modification it can be utilised to study the velocities of such reactions as the inversion of sucrose.

Patterson and McMillan (*Trans. Chem. Soc.*, 1908, 93, 1041) devised a polarimetric method for the study of the velocity of intramolecular change; and it appears as if this application of the polarimeter might be of the most general character. The method depends upon the fact that the optical

rotatory power of a solute is markedly influenced by the solvent in which it is used ; or, conversely, that the rotation of an optically active solvent is affected by the presence of an inactive solute. Thus, if ethyl tartate be used as a solvent for a syn-aldoxime, the rotatory power of the tartate will have a fixed value at the moment of solution ; but, if the syn-oxime be converted into the anti-aldoxime, a new rotatory power will be observed. By taking readings of the polarimeter at intervals during the conversion of the syn- into the anti-form, it is possible to follow the course of the intramolecular rearrangement of the oxime.

Further applications of this method are very easy to foresee. It might be employed to detect the presence of racemic compounds dissolved in an optically active solvent ; or it could be used to estimate many reaction velocities in cases in which

it is undesirable to introduce any reagents other than those used in the actual reaction itself. In fact, it appears to be one of the most widely applicable of the methods which have recently been devised.

These few examples will be sufficient to draw attention to the possibilities which seem at present to be lying dormant. There is no doubt that under present conditions it has become necessary in many cases to have recourse to rapid methods of experimental work in preference to older and slower ones ; and in some circumstances it is often better to have a quick and fairly accurate method rather than a more laborious though more refined process. In this direction the ordinary chemist might with advantage seek to adapt to his needs certain parts of the technique of the serum therapeutic laboratories ; for there this problem has been worked out in many instances.

THE SIMPLE IRON CYANIDES.

By HERBERT E. WILLIAMS.

Ferrous Cyanide.—When hydrogen or calcium ferrocyanide is distilled with a mineral acid, or precipitated with a solution of a ferrous salt, a white insoluble compound is obtained of ferrous ferrocyanide, $\text{Fe}''_2\text{Fe}''(\text{CN})_6$, although in this compound the ratio of iron to cyanogen is as 1 : 2, yet the compound is not simple ferrous cyanide, but a polymeric compound of a more complex structure ; two of the three atoms of iron occupy a basic position, while the third is closely associated with the six cyanogen groups.

If a soluble double nickel cyanide is precipitated in solution with a ferrous salt, a white precipitate of insoluble double ferrous nickel cyanide is obtained, from which the whole of the ferrous iron may be removed by treatment with a caustic alkali, with regeneration of the soluble nickel double cyanide, no ferrocyanide being formed



In this case all the iron occupies the basic position, but the cyanogen is combined in the complex anion $\text{Ni}(\text{CN})_4$.

It has been shown that if potassium cyanide solution is added to a solution of a ferrous salt, a bulky orange-red precipitate is formed of a more simple iron cyanide than those described above. On analysis the compound is not pure ferrous cyanide, two molecules of the latter body being combined with one molecule of potassium cyanide.

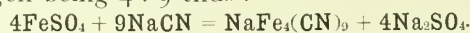


No attempt, however, seems to have been previously made to note the result of substituting other alkaline cyanides for the potassium salt, and the results of an investigation on these lines are given below.

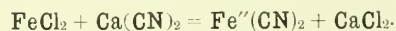
With ammonium cyanide solution an orange-coloured precipitate is obtained, very similar in appearance to the potassium compound, but containing ammonium cyanide in which the ratio of iron to cyanogen is as 1 : 3, thus :—



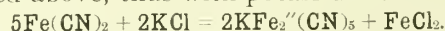
With sodium cyanide a compound is obtained which is nearer to pure ferrous cyanide than either of those above mentioned, the ratio of iron to cyanogen being 4 : 9 thus :—



As pure, heavy metal precipitates of the ferrocyanides, etc., are obtained by precipitating the calcium salt with an excess of a metallic salt, it was thought that pure ferrous cyanide might be obtained by precipitating the ferrous salt with a solution of calcium cyanide ; this result actually takes place when a solution of freshly prepared calcium cyanide is added to an excess of ferrous chloride, an orange-coloured precipitate of what was proved to be pure ferrous cyanide being formed thus :—



If ammonium, potassium, or sodium chloride is added to the precipitate, prepared as above, and agitated, ferrous chloride is liberated in amount corresponding to the formation of the double salts described above, thus with potassium chloride :—



These orange-coloured compounds oxidise and turn blue when exposed to the air, but may be easily washed by decantation with freshly boiled, oxygen-free water ; they are completely decomposed when boiled with dilute mineral acids out of air contact, and are converted into blue compounds by oxidising agents, such as nitric acid, or by the addition of a ferric salt solution ; these blue compounds differ from the blue ferric ferrocyanides, both in physical appearance and chemical properties, the colour being lighter but more dingy, and quite devoid of bronze lustre ; when decomposed by alkaline hydroxide solution in the cold, ferric hydroxide is precipitated and an orange-red solution obtained, which, on warming, deposits considerable amounts

of either ferric hydroxide, or the black ferrosferric hydroxide, with formation of a ferrocyanide in solution.

The orange-coloured ferrous cyanides described above form a series thus:—

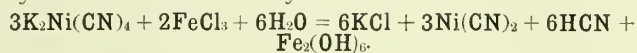
Name.	Formula.	Ratio Fe:CN.
Ammonium ferrous cyanide.	$\text{NH}_4\text{Fe}(\text{CN})_5 = \text{NH}_4\text{CN}:\text{Fe}(\text{CN})_2$	1:3
Potassium ferrous cyanide.	$\text{KFe}_2(\text{CN})_5 = \text{KCN}:\text{2Fe}(\text{CN})_2$	2:5
Sodium ferrous cyanide	$\text{NaFe}_4(\text{CN})_9 = \text{NaCN}:\text{4Fe}(\text{CN})_2$	4:9
Ferrous cyanide	$\text{Fe}(\text{CN})_2$	1:2

This same sequence is met with in the heavy metal ferrocyanides, if a solution of the heavy metal salt is added to solutions of ammonium, potassium, sodium, and calcium ferrocyanide respectively, of equivalent strength and under identical conditions, the precipitate obtained from the calcium salt is a pure heavy metal ferrocyanide free from calcium, whereas the others will contain alkali metals or ammonium in combination, the amount of which will be greatest in the case of the ammonium salt, and least in the case of the sodium one.

Ferric Cyanide.—When a ferric salt solution is precipitated by an alkaline cyanide, a reddish-brown precipitate is obtained consisting wholly of ferric hydroxide, free hydrocyanic acid being in solution

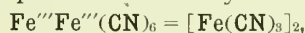


Also simple double ferric cyanides do not appear to exist, for if a ferric salt is added to a solution of sodium nickel cyanide, a precipitate occurs after a few seconds consisting of a mixture of ferric hydroxide and nickel cyanide.

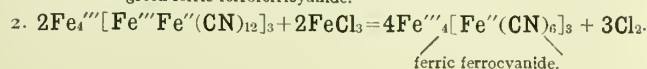
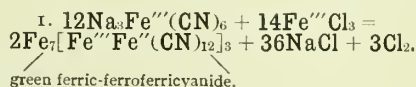


A similar action takes place if the double zinc cyanide is substituted for the nickel salt.

When ferric sulphate is added to a solution of barium ferricyanide a compound is formed in which the ratio of ferric iron to cyanogen is as 1:3, as it would be for ferric cyanide; the compound formed is not, however, ferric cyanide, but is found to be ferric ferricyanide, and, like the corresponding ferrous ferrocyanide, it may be considered as a polymeric compound of ferric cyanide thus:—



of greater complexity, in which the two atoms of iron exist in different conditions. This compound has not been prepared in the solid state, for, on evaporating the solution, the compound decomposes; if a very strong solution of ferric chloride is added to a strong solution of a ferricyanide, such as may be obtained with the lithium or sodium salt, the mixture rapidly rises in temperature, and deposits a blue or green precipitate, with copious evolution of chlorine; on warming, the green precipitate is changed to blue with a further evolution of chlorine. The reaction is probably expressed in the following terms:—



AN ADVISORY BOARD FOR THE CONTROL OF THE NEW SALE OF FOOD AND DRUGS ACT, 1913.

By CECIL W. WOOD.

DISCUSSING Mr. John Burns' new Sale of Food and Drugs Act, 1913, in the *Chemist and Druggist* of March 14th, 1914, Mr. E. J. Parry, B.Sc., F.I.C., points out the defects of one clause. This clause runs as follows:—

"The Local Government Board may, after such enquiry as they think necessary, make regulations defining an article of food in any matter affecting its nature, substance or quality."

Here we have a flagrant example of a proposal to place the control of an essentially scientific department in the hands of a highly paid Government official, who will probably be absolutely devoid of that scientific knowledge which is essential for anyone holding such a position. In the words of E. J. Parry: "This clause in effect gives absolute authority to a given authority (for the President of the Local Government Board is the Board) to erect standards for food which shall have legislative authority. It may possibly be argued that a minister in such a responsible position would not issue such regulations without careful consultation with all interests involved. But a view of past practice must convince anyone that, in general, the influence of the departmental officials is paramount and there is a tendency to prefer the highly academic to the highly practical." In support of his belief that the Local Government Board should not be granted such power, Mr. Parry states that the regulations of this Board concerning milk standards have materially lowered the quality of the milk supply throughout England instead of raising it.

The sale of food and drugs laws of England will continue to need reforming until they are controlled by experts in all branches of this particular work. Then, and only then, can it be hoped that these laws will be adequate for their purpose. The present intention of the new Act is anomalous to appointing a highly specialised research chemist to carry out the duties of Chancellor of the Exchequer "after such enquiry as he thinks necessary."

Mr. Parry brings forward the advantages of controlling these laws by means of an Advisory Board composed of members specialised in those qualifications necessary for the control of this work, and also gave a list of those departments of the work which should be represented. As a proof of the value of this suggestion, it is the author's intention to point out how these Acts are controlled in certain other countries. It is also interesting to note how the composition of Mr. Parry's suggested Advisory Board compares with those actually in existence. According to Mr. Parry any such committee should contain representatives of the following:—

- (1) The Government Department.
- (2) The Institute of Chemistry.
- (3) The Society of Public Analysts.

- (4) The Pharmaceutical Society.
- (5) The General Medical Council, and
- (6) Members of the London Chamber of Commerce as the representative of traders.

The value of these Boards appears to have been realised most in Australia, since four of the six States are already so provided. Moreover, the following extract occurred in the final report of the Interstate Conference and Royal Commission on Uniform Standards for Foods and Drugs for the Australian States which was issued in December, 1912.

" . . . And therefore the task of carrying out this Act (referring to the New South Wales Pure Food Bill) was entrusted by Parliament to the Board of Health of New South Wales and the permanent staff of the Department of Public Health; and, to enable it to act with necessary knowledge, it was furnished with an Advisory Committee, which consisted of the President of the Board (but of no other member), and of medical men, merchants, chemists, and others on whose recommendation the Board was directed to make regulations under the provisions of the Act. This direction, then, has placed the administration of the pure food law exclusively in the hands of the central authority only; and consequently the law has been carried out in New South Wales with great regularity and equable thoroughness, and with much more uniformity than was possible elsewhere."

Out of the six Australian States, only the laws of Queensland and Tasmania have not up to the present arranged for the appointment of Boards of Health or Advisory Committees. The following is the composition of the Boards of the other four States:—

NEW SOUTH WALES.

Pure Food Act, 1908, Advisory Committee.—The Governor is to appoint an Advisory Committee from the following persons:—

- (a) The President of the Board of Health, who shall preside.
- (b) The Professor of Chemistry in the University of Sydney.
- (c) A bacteriologist.
- (d) A legally qualified medical practitioner.
- (e) The Medical Officer of Health, metropolitan combined sanitary districts.
- (f) The Senior Analyst in the Department of Public Health.
- (g) A representative of the Pharmacy Board.
- (h) A representative of the Chamber of Commerce.
- (i) A representative of the Chamber of Manufacture. And persons not less than one nor more than three in number conversant with trade requirements.

With the exception of those in the employ of the public service, these members are paid attendance fees, which must not exceed two guineas each per sitting, and their appointment lasts for two years, but with the possibility of reappointment.

The Governor may remove any member on the recommendation of the Board, and has one vote and also a casting vote in cases of equality, whilst any five members constitute a quorum.

VICTORIA.

Adulteration of Food Act, 1905.—The composition of the Food Standards Committee, appointed by the Governor, is as follows:—

- (a) The Chairman of the Board, who shall preside.
- (b) A professor or teacher of chemistry in the University of Melbourne.
- (c) A professor or teacher of physiology in the University of Melbourne.
- (d) The Director of Agriculture.
- (e) The Medical Officer of Health in the city of Melbourne.
- (f) And four other additional expert members to be appointed by the Governor in Council.

The information given in the case of New South Wales is the same for Victoria. In addition there is the following clause, that any analyses or chemical investigations required by the Committee to enable it to make recommendations, under this Act shall be conducted in the Government Analytical Laboratory or other approved laboratory.

SOUTH AUSTRALIA.

Food and Drugs Act, 1908.—The Advisory Committee is composed as follows:—

- (a) The Chairman of the Central Board of Health, who acts as president.
- (b) A professor of chemistry in the University of Adelaide.
- (c) Government Analyst.
- (d) Chief Officer of Health for the city of Adelaide.
- (e) Three persons acquainted with trade requirements.

No mention is made of any fees which unofficial members are entitled to receive in return for their services.

WESTERN AUSTRALIA.

Health Act, 1911.—The Advisory Committee is appointed by the Governor as follows:—

- (a) The Commissioner, who shall act as chairman.
- (b) The Government Analyst.
- (c) A bacteriologist.
- (d) Two other persons conversant with trade requirements who shall be appointed for not exceeding one year, but eligible for re-appointment.

The fees paid to members not employed in the State public service must not exceed one guinea each per sitting, and no member shall receive more than £50 in any one year. The clerk of the Commissioner shall be the clerk of the Advisory Committee, and any three members constitute a quorum, whilst the Chairman has one vote and a casting vote in cases of equality, and any member can be removed by the Governor.

AUSTRALIAN COMMONWEALTH.

Commerce (Trade Descriptions) Act, 1905.—This does not arrange for the appointment of any definitely composed committee, but contains the following statement:—

“The Governor-General may make regulations not inconsistent with this Act, prescribing all matters and things required or permitted by this Act to be prescribed, or which are necessary and convenient to be prescribed, for carrying out or giving effect to this Act, and particularly for the analysis of samples taken under this Act, and the extent to which certificates of analysis shall be *prima facie* evidence in proceedings under this Act of the facts therein stated.”

STATUTORY POWER OF ADVISORY COMMITTEES.

As a result of the deliberations of these Advisory Committees recommendations are made, from time to time, by them to the Board or the High Commissioner of the State, which are made legal if considered advisable. The powers granted to them vary according to the State, and it will be interesting to see what powers are granted to the Advisory Committees of Victoria, New South Wales, and Western Australia.

The following clauses are common to both the New South Wales and Victoria Pure Food Acts:—

(1) “Prescribing standards for the composition, strength, purity, or quality of any food, drug, substance or compound, or for the nature or proportion of any substance which may be mixed with or used in the preparation or preservation thereof, or prohibiting the addition of any substance to any article of food.

(2) “Prohibiting such modes of manufacture and of preparation or preservation of articles of food as may be specified.

(3) “Prescribing methods of analysis, chemical and physical, to be applied in the analysis of any article of food or other article, substance or compound submitted for analysis under these Acts.

(4) “Exempting any package or food or drug from any provisions of this Act relating to marking or labelling.

(5) “Prohibiting the use of substances or methods that may be specified in the catching, feeding or drugging of animals shortly prior to death, such animals being intended for sale for the food of man.

(6) “Requiring the destruction or denaturation of articles of food that have become deteriorated or impoverished in such degree as may be specified and of such remainents of articles of food as may be specified.

(7) “Requiring statements or labels that may be specified to be written on or attached to articles of food, or to packages containing such articles and prohibiting the use in such statements or labels of words that may be specified.

(8) “Fixing rates for payments of samples of food or drugs taken and for payment of analysts for analyses under the Act.

(9) “Prescribing penalties not exceeding ten pounds for Victoria, and twenty pounds for New South Wales, for any contravention of any regulation, together with a continuing penalty not exceeding two pounds *per diem* in the case of New South Wales, and

(10) “Generally for carrying out the provisions of this Act, and for securing the wholesomeness, cleanliness, freedom from contamination and adulteration of any food, drug, or article, and for securing the cleanliness of receptacles, places, and vehicles used for the manufacture, preparation, storage, packing, carriage, or delivery of any food, drug, or article.”

The wording of the following clauses varies in the two States, (a) being that of the Victoria regulations, and (b) that of New South Wales.

(a) “Prohibiting in the manufacture, preparation, storing, preservation or packing or conducting by tubes, pipes, pumps and their connections or otherwise or in the delivery of any article of food for sale the use of appliances containing any substance that may be specified and any substance in any proportion that may be specified.”

(b) Similar to (a), with omission of the following words:—“conducting by tubes, pipes, pumps and their connections or otherwise.”

The power of the Advisory Committee in Western Australia seems to include a much bigger sphere of control. Thus, the Governor on the advice of the Advisory Committee may, from time to time, make regulations with respect to all or any of the following matters, namely:—

(1) Prescribing the fees to be paid by persons applying to be approved and registered as analysts.

(2) Prescribing the fees to be paid by persons for the analysis or examination of foods, drugs or disinfectants.

(3) For the taking of samples of foods, drugs, and disinfectants, and for the examination or analysis thereof.

(4) Setting and appointing standards for the composition of foods, drugs, and disinfectants, and, subject as hereinbefore provided, with regard to spirits, the amount of dilution, if any, to be allowed in the sale by retail of any foods or drugs.

(5) Setting and appointing standards of the amount of deterioration or natural poverty, if any, in any food or drug to be permitted without prosecution under the provisions of the Act.

(6) Setting and appointing standards of the amount and kind, if any, of foreign substances to be allowed for the preservation, colouring, or flavouring of goods.

(7) Setting and appointing methods of analysis and examination (either exclusive or optional) whereby the composition, quality, or conformity or want of conformity to standard of any food or drug shall or may be ascertained.

(8) Prohibiting the sale of milk or any other food whatsoever, containing bacteria in excess of a prescribed number.

(9) (a) Ordaining that any food or drug shall be labelled.

(b) Prescribing what information relative to the food or drug shall be set out on the label.

(c) Ordaining that any label used in compliance with a requisition of this Act shall contain information in addition to that required by this Act.

(d) Regulating generally the wording, printing, size, colours, and style of labels to be used in conformity with any requisition of this Act or any regulation.

(e) Prohibiting the sale or offering or exposure for sale of any food or drug which is not labelled as prescribed.

(f) Granting conditional exemption from any requisition of the regulations regarding labelling in respect of any food or drug, and prescribing the conditions of such exemption.

(10) Requiring tinned or packed food to bear upon the tin or package the date of the manufacture, preparation, packing or importation thereof.

(11) Regulating marks to be applied to food, drugs, or disinfectants deemed by the Commissioner wholesome or effective, and prescribing the fees to be paid for the inspection and marking of food, drugs, or disinfectants.

(12) Discriminating in respect of labelling between drugs supplied on the order of a legally qualified medical practitioner or by a pharmaceutical chemist and drugs not so supplied.

(13) Prescribing the marks or bands to be applied to food which is condemned.

(14) Prohibiting the sale, or the offer or exposure for sale, within prescribed districts, of meat which is not marked or branded with prescribed marks or brands, and appointing places within such districts at which all unmarked or unbranded meat shall be exhibited for inspection.

(15) For the prevention of adulteration of foods, drugs, and disinfectants, and for the prohibition of the sale of foods, drugs, or disinfectants not in conformity with the appointed standard.

(16) Generally for all other matters and things necessary to give effect to this Act.

In Belgium the issuing of any new regulations that may be necessary seems to be the duty of the Minister for Agriculture, although "Les Dispositions Légales et Réglementaires concernant les Denrées Alimentaires et l'Expertise des Viandes," which is stated officially to contain all the information on this subject, does not state definitely on whom this duty falls and the extent of the power granted for the purpose.

The French anti-adulteration laws possess arrangements for a special technical committee for the suppression of frauds. This is probably very similar to those of the Australian States, but the author has not been able, up to the present, to ascertain its exact composition and statutory powers. This information, together with that concerning Germany and the United States, will be communicated in a further article if sufficiently interesting.

The New Zealand Sale of Food and Drugs Law of 1908 contains the following statement:—

The Governor may from time to time, by order in Council gazetted, make regulations:—

(a) "Prescribing the standard of strength, weight, quality or quantity of any food or drug, or of any ingredient or component part thereof.

(b) "Prohibiting the addition of any specified thing, or of more than the specified quantity or proportion thereof, to any food or drug.

(c) "Prohibiting any modes of manufacture, preparation, or preservation of any food or drug.

(d) "Securing the cleanliness and freedom from contamination of any food or drug in the course of its manufacture, preparation, storage, packing, carriage, delivery, or exposure for sale, and securing the cleanliness of places, receptacles, appliances, and vehicles used in such manufacture, preparation, storage, packing, carriage or delivery.

(e) "Prescribing the mode of labelling food or drugs sold in packages, and the matter to be contained or not to be contained in such labels.

(f) "Prescribing the method of analysis of any food or drug.

(g) "Fixing fees to be paid in respect of the analysis of any food or drug by an analyst.

(h) "Prohibiting the sale of specified articles of food otherwise than by weight.

(i) "Prescribing fines not exceeding £50 for the breach of any regulations.

(j) "Generally for carrying out the purposes of this Act."

The only information contained in the Adulteration of Food and other Articles Act of Canada of 1906 is that the Governor in Council may, from time to time, make such regulations as to him seem necessary for carrying the provisions of this Act into effect.

It is thus seen that Mr. E. Parry's suggested committee agrees very closely on the whole with those of the Australian States.

The author ventures to propose the list given below, which although in no way supplanting that of Mr. E. Parry, gives its composition in more detail, and is arranged on the lines of those just considered in this article.

The President of the Board of Agriculture, who shall act as Chairman.

The Government Analyst.

A medical officer of health, preferably of the city of London.

A representative of the Institute of Chemistry.

A representative of the Society of Public Analysts.

A representative of the Pharmaceutical Society.

A professor of chemistry in the University of London.

A professor of physiology in the University of London.

Persons conversant with trade requirements, represented by the London Chamber of Commerce.

A bacteriologist might with great advantage be included in the Committee, but it is very doubtful whether our laws and authorities have yet realised sufficiently the importance of bacteriology as applied to public health.

THE KAISER-WILHELM INSTITUTE FOR CHEMISTRY.

By PROFESSOR J. B. COHEN, B.Sc., PH.D., F.R.S.

IN describing the aims of the Institute, which was formally opened by the German Emperor on October 23rd, 1912, Professor Emil Fischer said: "During the last hundred years the study of experimental chemistry was exclusively confined to the universities and technical schools, and no one will deny the extraordinary achievements in furthering the study of science of these schools of chemistry, which were fashioned on Liebig's celebrated model of the Giessen University. The close union between

German chemists and chemical manufacturers. Subsequently a society, registered under the name of the Verein Chemische Reichsanstalt, was founded, with a minimum subscription of £50 a year, or a cash payment of £1 000, which gave the right to one vote for each £1,000 subscribed. The society began with an aggregate subscription list of £2,450, whilst a collection among the members produced a sum of £19,000. Handsome donations were also forthcoming from the heads of some of the large industrial



DIRECTOR BECKMANN IN HIS LABORATORY.

teaching and research existing in these institutes was frequently the only real form of scientific study, and has become celebrated as the origin of the great development of technical chemistry in Germany."

He then went on to point out some of the disadvantages of the system owing to the great increase in the number of students during the last thirty years, and the consequent additional demand on the time of the teacher.

To remove the burden of teaching from the shoulders of those who possessed the genius for research has been the object of the present scheme, namely, that of founding a research institute in chemistry, similar to the physical institute, which has proved such an unqualified success. The scheme, which was first seriously discussed in 1905 at the instigation of Professors E. Fischer, Nernst and Ostwald, received the enthusiastic support of all the

firms, Dr. L. Mond, F. Krupp, E. Solvay, Professor Harries, and many others.

A further sum of £10,000 was contributed by the Kaiser-Wilhelm Gesellschaft, a society founded by the Emperor to promote a more general scheme of scientific research. The funds soon reached the substantial figure of £55,000, with an annual income of £6,000, half of which was contributed by the Verein and half by the Kaiser-Wilhelm Gesellschaft.

The Institute for Chemistry is divided into sections, each of which is under the direction of specialists, with a consultative committee of experts. Dr. Beckmann is director of the institute, and is assisted by Dr. Willstätter and Dr. O. Hahn. Through the munificence of W. Koppel, a physical and electro-chemical section has also been founded under the direction of Dr. Haber.

The Kaiser-Wilhelm Gesellschaft, it may be added, in addition to assisting the Chemical Institute balance room, photographic, physical and optical rooms, library, etc. The first floor is occupied by Dr. Willstätter, and the ground floor by Dr. Hahn, and are similarly arranged and equipped. In the basement are installations for vacuum and pressure machines, electric motors and accumulators, and cold storage rooms. The ventilating exhausts are in a chamber under the roof, where distilled water is also made.



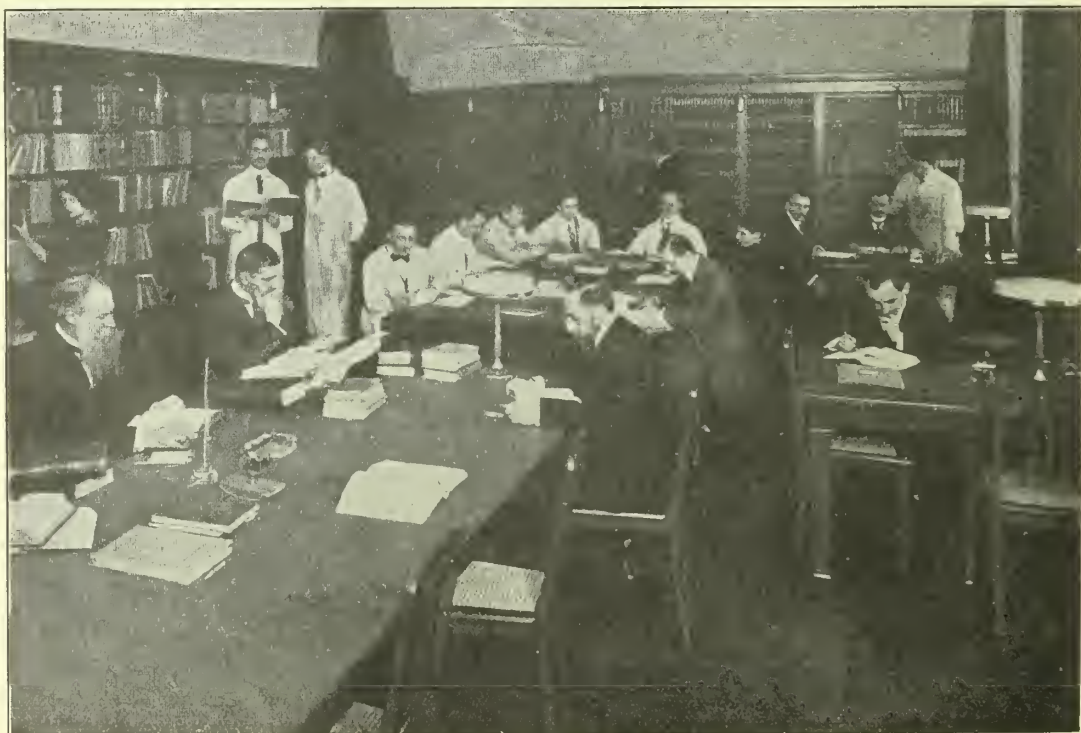
PROF. WILLSTÄTTER'S LABORATORY.

has planned sections for fuel research, biology, physiology, therapeutics, and for a zoological station at Rovigno. Through the munificence of other donors, sections for the study of aviation and the pursuit of Oriental archaeology are contemplated.

The Kaiser-Wilhelm Institute for Chemistry is situated at Dahlem, not far from Berlin. It forms a three-sided block, consisting of three floors and a basement. The top floor, which is occupied by Dr. Beckmann, has five separate laboratories with accommodation for about a dozen workers; also a

as a cryoscopic solvent. He has invented a new porcelain burner for analysis, and a sodium lamp

Both the chemical and physical institutes have already given a good account of themselves, and the first volume of researches, covering a period from April, 1912, to October, 1913, contains the following important contributions: There are no less than seven papers by Dr. Beckmann and his assistants, relating to the use of various liquids (SO_3 , SO_2Cl_2 , $\text{SO}_2 \cdot \text{OH} \cdot \text{Cl}$ and CrO_2Cl_2) for ebullioscopic experiments and of iodine



THE GENERAL LIBRARY.

for optical work. Dr. Willstätter has published seven papers, in which he has extended his brilliant investigations on chlorophyll, and describes the use of metallic osmium as an oxidising catalyst. There are also two papers by Dr. Otto Hahn on Actinium and Uranium X_2 . Dr. Haber, of the physical institute, has described a new fire-damp indicator which takes the form of a whistle. A record such as this in the short period of eighteen months shows that the Institute is in full activity, and has already more than justified its existence.

Perhaps the most striking feature of this new movement is the whole-hearted sympathy which it has aroused, not only among scientific men and the

heads of the great industrial firms, but in members of the Government, and even in the Emperor himself, who has taken no small share in bringing the scheme to a successful issue.

There is no doubt that the recognition of the commercial importance of purely scientific research, as distinguished from industrial or technical research by the German people, who are daily made to feel its increasing industrial value, is largely accountable for this result, and one can only hope that in time the same widespread interest in pure science may promote the endowment of similar research institutes in this country.

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

CHAPTER V.

IN the present chapter it is proposed to present some account of the catalytic influence of surfaces upon chemical reactions. Now, as far as practical utility is concerned, the only process in which this influence has been at all investigated is that of combustion. A few observations relating to the rôle played by the walls of the containing vessel are to be found in chemical literature, but these are hardly worthy of notice here. Cold surfaces, of course, are ruled out of consideration, for their influence is well known to be the antithesis of catalytic; indeed, it is to the retarding effect of cold surfaces upon fuel combustion that we owe the present smoke and soot nuisance. The discussion, therefore, narrows itself down to a consideration of the influence of hot surfaces.

The subject, in its theoretical aspect, is by no means a new one. Every student of chemistry is acquainted with Davy's discovery (1817) that a warm platinum wire, held in a non-explosive mixture of coal gas and air, continues to glow until nearly all of the oxygen has disappeared. In 1823 the phenomenon was investigated by Dulong and Thénard, and independently by Döbereiner, who showed that all solids, and not merely the members of the platinum group, as Davy thought, possess the power of promoting combustion at temperatures below the ignition point, the influence varying with the specific character and fineness of division of the solid concerned. Henry and Graham have also recorded observations bearing upon the same subject; whilst attempts to explain the phenomenon led, in 1834, to a long controversy between Faraday and de la Rive, of which more will be mentioned later.

With the exception of the well-known Döbereiner lamp, however, the practical application of these

facts lagged far behind their recognition in scientific circles—a circumstance which was due, in large measure, to the influence of Siemens, who created the impression that contact with hot surfaces retards combustion by promoting dissociation. Starting with this erroneous deduction, it came to be generally accepted that contact between combustible gases and hot surfaces should be avoided as far as possible.

Among the few who recognised the fallacy of Siemens' reasoning, mention will be made only of Bone, for it is to this investigator and his collaborators that we owe much of our knowledge of what is called "surface combustion." As a result of his researches on this subject, begun in 1902, the following facts have been definitely established:—

(1) All incandescent surfaces are capable of accelerating gaseous combustion; and to an approximately equal degree, for the wide differences between the catalytic powers of various surfaces at low temperatures gradually diminish as the temperature rises, until at incandescence they practically disappear.

It might be noticed, in passing, that this latter conclusion is borne out by Knietzsch's experiments, mentioned in Chapter II. Thus, from Fig. 1, it will be seen that at 850°C . there is little difference between the catalytic powers of platinum, pyrites cinders, or broken porcelain in sulphuric anhydride formation.

(2) The combustion takes place *heterogeneously*, that is to say, only in layers immediately in contact with the incandescent surface, and not *homogeneously*, or equally throughout the system.

(3) The catalytic process depends primarily upon condensation or absorption of one or other (and possibly both) of the reacting gases by the surface, whereby the gases are rendered "active," probably by ionisation.

(4) The incandescent surface becomes strongly negatively electrified during the combustion.

The first of these observations is utilised in the "Surface Combustion" process now to be described; the remainder, being associated more with the theory of the subject, will be dealt with towards the end of the chapter.

SURFACE COMBUSTION.

In this process an explosive mixture of a combustible gas and air is brought into contact with a refractory solid placed in proximity to the body to be heated. The mixture should be in the proportions for complete combustion, or with air in slight excess, and must necessarily be injected on to, or forced through, the solid at a velocity greater than the speed of ignition of the mixture. On now igniting the issuing gases, the surface of the solid rapidly becomes incandescent and the mixture continues to burn there without the formation of flame, but with the development of a large amount of radiant heat.

To make clear the *modus operandi*, two forms of apparatus, corresponding to the two fundamental types, will be described. [See also CHEMICAL WORLD, 1912, I., 198.]

The first, shown diagrammatically in Fig. 5, and known as the "Diaphragm" adaptation, comprises a diaphragm A of porous refractory material, through which the gaseous combustible mixture is forced under slight pressure from the chamber B. Soon after ignition of the gases on the exit face, the surface layer attains incandescence and, by suitably adjusting the quantity of entering gases, the incandescence can be maintained there, without any unburnt gases escaping whatsoever. This form finds special application for domestic heating, such as roasting, grilling, etc., and more especially for the concentration and evaporation of solutions, in which case the apparatus is inverted over the concentrating pan.

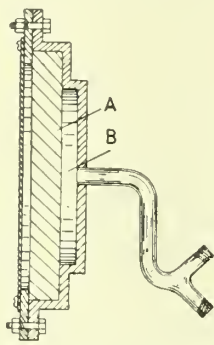


FIG. 5.—SURFACE COMBUSTION DIAPHRAGM.

The degree of porosity is sufficient in all cases to relegate the question of back-firing beyond the need for consideration. The fineness or coarseness is determined, of course, by the quantity and pressure of the combustible mixture employed. For rich gases a fine grade is employed, whereas with poor gases and moderate temperatures a coarser grade will suffice. To avoid clogging of the pores, and the consequent necessity for the renewal of the diaphragm, the ingoing gases are preferably freed from dust. Temperatures of 800–900° C. (using coal gas) can readily be obtained by this means.

In the second and more important form of the apparatus, known as the "Granular Bed," the

diaphragm is replaced by a number of refractory granules, and it is then on the surface of each of the granules that incandescence occurs, rendering the whole bed a white-hot mass. Thus, in Fig. 6, is shown a muffle furnace C surrounded by lumps of refractory material D, to which the combustible mixture in combining proportions is supplied by the pipe E, at a velocity in excess of the speed of inflammation of the mixture. By this means high temperatures can readily be obtained. The maximum naturally depends upon the working conditions, but in such a furnace as just described temperatures in the neighbourhood of 1,400° or 1,500° C. become available.

The choice of refractory material is, of course,

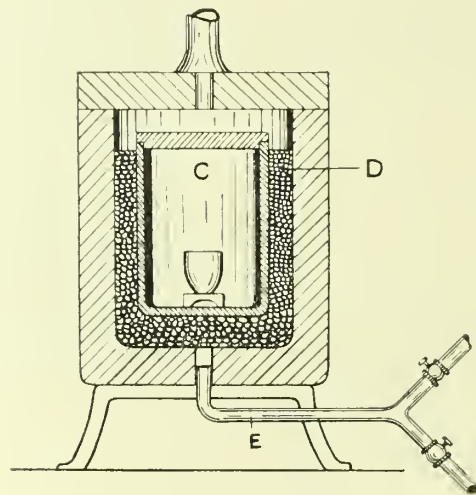


FIG. 6.—MUFFLE FURNACE.

determined by the temperatures involved. In the ordinary course a number of substances are at our disposal, e.g., calcined fireclay, ganister, etc. But when high temperatures are in question, the number of refractory materials is very limited. This will be understood when it is noted that platinum can easily be melted and even carborundum decomposed by this process. Practically all solids are then eliminated, with the exception of calcined magnesia and carborundum, both, however, being subject to certain conditions.

Clearly, this second method is capable of a large number of industrial modifications. The refractory material may function as a hearth or furnace, or it may be packed into tubes which are immersed in water for steam-raising purposes; or in metals and alloys which it is required to melt. In fact, as yet, the full range of application cannot be defined.

Undoubtedly, the generation of steam demands primary consideration. And, since in this connection three forms of apparatus are available, the description of these is considered to be sufficient for our present purpose, as covering the greater part of the field of application.

In the first form, shown in Fig. 7, the boiler is constructed on the multitubular arrangement, but each tube F is now packed with refractory

granules. The constituents of the combustible mixture are admitted to the series of tubes from feeding chambers G, H, and, being ignited, burn at or about the entrances of the tubes, which are plugged with firebrick I. The remainder of each tube serves to extract the sensible heat from the products of combustion. Any heat still remaining is employed for raising the temperature of the feed-

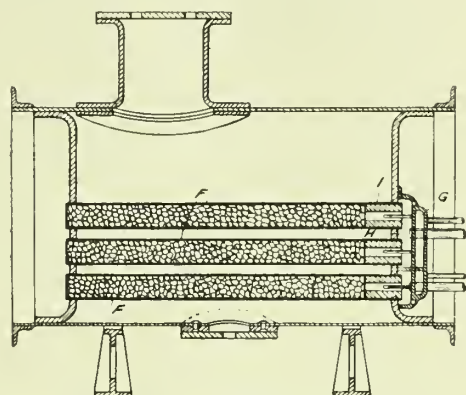


FIG. 7.—SURFACE COMBUSTION BOILER.

water by passing the gases through tubes packed with refractory material, which are immersed in the water. Control of the steam supply is effected either by adjustment of the quantity of ingoing mixture or by arranging the boiler tubes in groups which can be requisitioned as required.

The principle underlying the second method is that utilised in the above-mentioned feed-water heater. The fuel—in this case liquid fuel—is first burnt in a chamber J, Fig. 8, situated within, or in close proximity to, the shell of the boiler, and the resulting products are then passed through the boiler tubes K, charged, as before, with refractory material. The granular body then facilitates the heat transmission through the walls of the tube to the surrounding water by mixing the gases in transit, thereby assisting the combustion of any fuel not fully burnt originally, and by radiating heat to the walls.

The third method applies to the firing of boilers of all kinds. Inside the flue of the boiler rails are laid down upon which run flat trays L, Fig. 9, or hearths of fireclay, firebrick or other material. The rails, preferably adjustable in height, are provided for the withdrawal of the trays; and, to facilitate discharge of the granular material, the trays are adapted for tipping. A pipe M conveys the

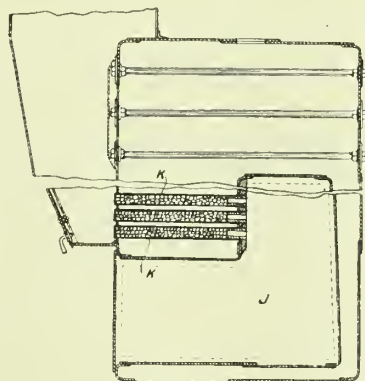


FIG. 8.—SURFACE COMBUSTION BOILER.

gaseous mixture to the hearth, uniform delivery being secured by the provision of apertures N at various points. The glowing mass developed on ignition of the mixture serves to heat the boiler in the ordinary way. Flames can be obtained, if desired, by reducing the proportion of air in the mixture and admitting a further supply to the flue to complete the combustion.

Among other applications might be mentioned, *e.g.*, the melting of metals and alloys, furnaces of

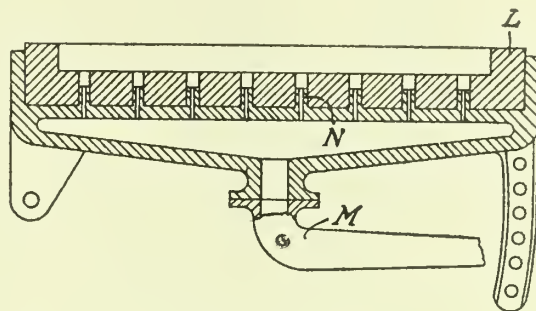


FIG. 9.—BOILER RAILS.

all descriptions, galvanising, oil gasification and distillation, welding, etc.

The advantages of the process are manifold. In the first place, it is adapted for the employment of a large variety of combustible gases—blast-furnace gas, producer gas, water gas, coke-oven gas, coal gas, etc., and for what have been regarded hitherto as waste gases. What is more important still, the process is remarkable for its efficiency; in the case of tests with a gas-fired multitubular boiler, for instance, efficiencies of about 92–94% have been recorded. Moreover, the process is one of great flexibility, since the temperature can be almost instantly varied by altering the rate of feed of the gaseous mixture. The temperatures produced are of a high order, whilst the heat can be concentrated at any desired point.

During the last year or so experiments have been made with a view to the utilisation of liquid fuel in Surface Combustion apparatus. Already several patents have been taken out for apparatus in which the liquid fuel is first atomised by ingoing air, and the resulting mixture then delivered to the combustion bed. Such an application has already been hinted at in connection with Fig. 8. For the purposes of illustration, the modification necessary for the furnace shown by Fig. 10 will suffice. Air under pressure passes along the outer O of two concentric tubes, and comes into contact, at a short distance from the lower face of the bed P, with a jet of liquid fuel, or of spray from an atomiser, supplied by the inner pipe Q. Seeing that the two constituents of the mixture come into contact with the incandescent bed at the time of mixing, condensation of the liquid fuel on the walls of the outer tube is avoided. In all cases it is necessary to pre-heat the bed by means of combustible gas.

Incidentally it might be remarked that the whole

tendency of present-day power production is towards the substitution of gaseous or vapour fuel for the solid variety. The process under consideration, by its utilisation of combustible gases and liquid fuel, bridges the gap between the steam engine and the internal-combustion engine, which is destined ultimately to replace it. Whether or not the

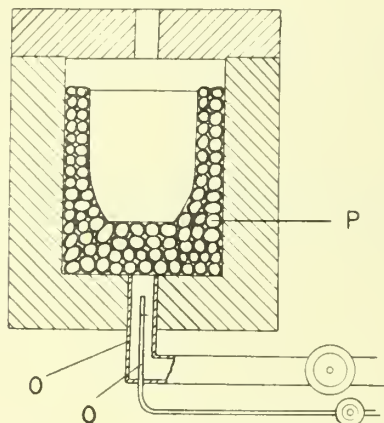


FIG. 10.—LIQUID FUEL MECHANISM.

replacement is complete depends to no inconsiderable degree upon the success attained by the Surface Combustion process.

The revolution in gaseous heating brought about by the application of the principle of accelerated combustion by hot surfaces, which has been outlined above, is largely due to the investigations of Bone and McCourt. It is only fair, however, to record that the process and, indeed, several of the small forms of apparatus, had already been patented in the U.S.A. by Lucke; but the British inventors are undoubtedly answerable for the extension and development of the method and the design of apparatus capable of establishment on an engineering basis.

With regard to the mechanism of the process, the fundamental fact that the surface acts as a catalyst cannot be gainsayed, nor yet the general manner in which the surface acts. In the course of the Faraday-de la Rive controversy, already referred to, the rival theories were fiercely debated, de la Rive maintaining that surface combustion consists essentially of a series of rapidly alternating oxidations and reductions of the catalyst, whilst Faraday strongly upheld the view put forward, first by Fusinieri (1825), that the function of the solid is to condense the reacting gases upon the surface, thereby producing in the surface layer a condition comparable with that of high pressure. Bone's experiments amply prove the correctness of Faraday's physical explanation.

Attempts to probe deeper than this have not yet resulted in anything very definite. It is known, nevertheless, that incandescent surfaces emit streams of electrons travelling at high velocities; and the action of hot surfaces in promoting combustion may ultimately be found to depend upon the formation of layers of electrified gas in which the chemical

changes proceed with extraordinarily high velocity under the influence of the corpuscular discharge. Excellent support for this view is found in the discovery that the catalyst becomes negatively charged during the combustion process.

Of great interest, too, is the fact that, at temperatures below the ignition point, the activity of a surface is greatly affected by previous contact with the gases. Thus, in most cases, exposure to the combustible gas enhances the catalysing factor, whereas contact with oxygen lowers it, though to a smaller degree. After attainment of a steady condition, the rate of combustion is found to be directly proportional to the pressure, if the gases are present in their combining proportions and the products of combustion are rapidly removed. When, however, one of the reacting gases is present in excess, the rate of combustion is then proportional to the partial pressure of the combustible gas.

INCANDESCENT GAS MANTLES.

From the present standpoint of surface catalysis, the subject of gas mantles possesses at least one feature of sufficient interest to render it worthy of mention.

Soon after Welsbach began his epoch-making investigations (1885) upon the luminous properties of the rare-earth oxides—the luminosity of these oxides, by the way, is not dependent upon catalysis—he came to the conclusion that, of them all, thoria appeared to be the most satisfactory as a mantle basis. But he also made the curious observation that the more the thoria was purified, the less the light obtained from it. Attempts to account for this led, in 1892, to the discovery of the power exercised by a trace of ceria in augmenting the emissivity of thoria, and to the consequent adoption for the mantle basis of a mixture of 99% thoria and 1% ceria—a mixture which numerous later attempts have failed to improve upon.

The added component is known as an "excitant." Pure thoria gives a relatively poor light, but the continuous addition of ceria gradually increases the luminosity to a maximum of tenfold when 1% is present, any further addition then diminishing the luminosity until, with 10%, the difference in effect is inappreciable. In present-day manufacture, the cotton or ramie web is impregnated with a 25–33% aqueous solution of thorium and cerium nitrates in the proportion of 99:1, together with a little hardening medium, *e.g.*, beryllium nitrate, if necessary.

The reason for the beneficial action is not definitely known, though catalysis, perhaps in conjunction with other phenomena, furnishes the likeliest explanation. Certainly, the power which many catalysts possess of existing in two or more states of oxidation applies to cerium, and the activity of ceria may perhaps be attributed to this.

In connection with the Nernst lamp, too, a similar phenomenon is to be observed, for the pure zirconia rod, which is heated by an electric current

until luminosity is reached, gives much less light than does a rod containing a little thorium, ceria or like oxide.

Furthermore, it might be mentioned that it has been proposed to employ fragments of mantle in

place of palladium asbestos as the catalyst in gas analysis, for the estimation of hydrogen, carbon monoxide or methane by combustion with excess of oxygen.

(To be continued.)

SURFACE TENSION AND SURFACE ENERGY AND THEIR INFLUENCE ON CHEMICAL PHENOMENA.

By R. S. WILLOWS, M.A., D.Sc., and E. HATSCHEK.

CHAPTER III. (Continued).

SUCH a relation between surface tension and vapour pressure was first established by Lord Kelvin, who demonstrated that the vapour pressure over a curved surface must be different from that over a plane surface of the same liquid. His proof cannot be given here, but the following simple considerations clearly show the connection between curvature

of surface and vapour pressure, and lead to an approximate formula expressing the latter in terms of surface tension and radius of curvature.

Consider a capillary immersed in water (Fig. 6) in which the liquid has risen to a higher level than that outside. As we ascend in the vapour from the plane surface, the vapour pressure decreases—exactly as the atmospheric pressure decreases when we rise from a lower to a higher level. If we call the vapour pressure at the level of the plane surface p , and that at

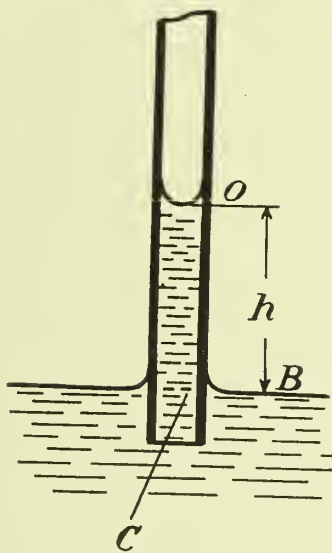


FIG. 6—CAPILLARY ACTION.

the height h above it p' , the latter is less than the former by an amount

$$p - p' = h\rho'g$$

where ρ' is the vapour density, which we assume to be constant over this small height, and g the gravity constant. Hence the vapour pressure in equilibrium with the concave liquid surface in the capillary is smaller than that on the plane surface. To obtain the difference we proceed as follows: The pressure at a point C in the capillary, which is on the level of the plane surface, B, must be equal to that on the latter, else there would be a flow of liquid in one direction or the other. If we imagine the whole arrangement placed in a vacuum, the pressure on B is simply the vapour pressure p . The pressure just above the curved surface at O, which we assume to be hemispherical, is greater than that just below it,

and we have shown above for an air bubble in liquid that this difference of pressure is $\frac{2\sigma}{a}$, where a is the radius of the surface. The pressure above the surface is of course p' , and the pressure just below the surface is accordingly $p' + \frac{2\sigma}{a}$. The pressure at the level C is then obviously equal to this pressure plus the weight of the column h of liquid, i.e., if we call the density of the liquid ρ

$$\text{Pressure at C} = p' + \frac{2\sigma}{a} + h\rho g.$$

As explained above, the pressure at C is equal to that at B, which is the vapour pressure on a plane surface, p , and we have accordingly

$$p = p' + \frac{2\sigma}{a} + h\rho g \text{ or } p - p' = h\rho g + \frac{2\sigma}{a}.$$

We know from above that $p - p' = h\rho'g$, and by introducing this value we obtain

$$h\rho'g = h\rho g + \frac{2\sigma}{a} \text{ or } \frac{2\sigma}{a} = hg(\rho' - \rho) = h\rho g' \cdot \frac{\rho' - \rho}{\rho'}.$$

If we finally reintroduce the value $p - p'$ for $h\rho g'$, we arrive at the equation

$$\frac{2\sigma}{a} \frac{\rho'}{\rho' - \rho} = p - p'$$

which establishes the desired relation between surface tension and radius of curvature on one hand, and the difference between the vapour pressures on the plane and curved surface on the other hand.

(This formula is only approximate; a stricter calculation leads to the equation

$$R\theta \log_e \frac{p}{p'} = \frac{2\sigma}{a\rho}$$

where R is the gas constant and θ the absolute temperature.)

In arriving at our formula we have assumed that the liquid in the tube stands at a higher level than outside, and that its surface is concave, which is the case when the liquid wets the tube, as for water or alcohol. If the liquid does not wet the tube, e.g., mercury—the level in the capillary is lower than that outside and the surface is convex. Our reasoning, however, still applies, and leads to the conclusion that the vapour pressure on the convex surface is greater than that on the plane surface. The formula covers both cases, since the radius must be given the opposite sign if the curvature is in the opposite

direction; it is positive when the surface is concave.

The approximate formula shows immediately that the smaller is a , the radius of curvature, the greater is the difference between the vapour pressure at the curved and at the plane surfaces. For very small values of a the difference becomes very marked; if we have a drop of water at 0° with a radius $\cdot 001$ mm. or $1\ \mu$, the equilibrium vapour pressure is greater than that at the plane surface by one part in a thousand, but if a is only 10^{-6} mm. or $1\ \mu\mu$, the equilibrium pressure required is more than double that at the plane surface. If the vapour in which such drops are suspended has the pressure corresponding to a plane surface, the drops will therefore tend to evaporate very rapidly; similarly, if drops of different sizes are present together, the large ones will grow at the expense of the small ones. The high vapour pressure of very minute drops also makes it difficult for condensation to begin in dust-free air; if dust particles are present and act as nuclei, the drops start their life with a fairly large radius, so that the vapour pressure and, consequently, the tendency to evaporation are reduced. Air entirely free from dust may be cooled to a temperature so low that the moisture present is eight times that required to saturate it before any fog is formed.

Similar considerations apply to the behaviour of porous bodies in an atmosphere containing vapour. Pores are substantially collections of capillary tubes. If the liquid whose vapour is present wets the body, the resulting surface is concave and the equilibrium pressure is therefore lowered, so that it is easy for condensation to take place in pores, even if the atmosphere is not saturated with vapour. This may account in part for the absorption of water by cotton wool, flannel, etc., although some of it is no doubt due to adsorption, which will be treated later.

CHAPTER IV.

WE shall now proceed to show that a reasoning analogous to that which led us to conclude that large drops of liquid grew at the expense of small ones can be applied to establish a very interesting relation between surface tension and the solubility of solids. Before doing so it is advisable to amplify what has been said already about this somewhat difficult subject, the surface tension of solids. We have already concluded that the surface energy of a liquid, which increases steadily with falling temperature, cannot disappear suddenly when the freezing point is reached, *i.e.*, when the liquid changes into a solid, so that the latter must necessarily possess surface energy and surface tension. The reasoning is further strengthened by the well-known fact that many amorphous substances, at least, behave in in other respects like liquids of extremely high viscosity. Thus steel balls placed on pitch gradually sink through it; asphalt and marine glue spread over glass plates at ordinary temperatures and pressures unless confined; a stick of sealing wax

clamped at one end in a horizontal position gradually sags, etc., although all these substances are at the same time sufficiently solid to give out a note when touched with a vibrating tuning fork. Since they all possess surface tension when liquid, we are forced to conclude that they also do so when solid, and that the surface tension then has a very high value. In the case of crystalline solids the analogy to liquids is much less complete, but still there is nothing to warrant us in supposing that the surface forces disappear at freezing; all we know is that their action is profoundly modified, and is presumably different in different directions or on different faces of the crystals.

To return to our problem, we may regard the growth of big liquid drops at the expense of small ones as resulting from the transfer of a quantity of liquid m from one to the other. Since the big drop has a smaller surface than an equal volume of small ones, this transfer leads to a decrease of surface energy and at the same time liquid is taken from a place of higher to a place of lower vapour pressure. The growth of particles in a precipitate or in a supersaturated solution is found to occur in a similar manner, *i.e.*, large crystals grow at the expense of small ones; but here we have to deal with the decrease in energy of a surface solid-liquid (instead of liquid-vapour) and the transfer of matter from a place where the osmotic pressure (instead of the vapour pressure) is higher to one where it is lower. The calculation was first carried out by Wilhelm Ostwald, subsequently corrected by Hulett, and leads to an equation formally identical with that given above

$$R\theta \log_e \frac{p'}{p} = \frac{2\sigma}{\rho a}$$

in which however, p is now the osmotic pressure in equilibrium with a large surface, *i.e.*, the ordinary osmotic pressure, p' that in equilibrium with a surface of the radius a , σ the surface tension solid-liquid, and ρ the density of the solid.

The osmotic pressures are proportional to the number of molecules dissolved in the same volume, or, in other words, to the solubilities of large and small particles respectively, and will be different if these solubilities are different. The latter is actually the case for the two substances examined by Hulett, calcium sulphate and barium sulphate. The solubility of the former (determined by electrical conductivity measurements) was 18.2 millimoles per litre for particles of a radius $a = \cdot 00003$ cm., and 15.33 millimoles for particles of a radius $a = \cdot 0002$ cm., so that the smaller particles show a considerably larger solubility. Since the osmotic pressures are proportional to the solubilities, we can write

$$\frac{p'}{p} = \frac{\lambda'}{\lambda}$$

where λ and λ' are the respective solubilities, and the formula thus becomes

$$R\theta \log_e \frac{\lambda'}{\lambda} = \frac{2\sigma}{\rho a}$$

It can now be used for the extremely important purpose of calculating σ , which is found to be 1,100,

dyne/cm. for calcium sulphate and 4,000 dyne/cm. for barium sulphate. These figures entirely confirm the conclusion to which we have come on general grounds, that the surface tensions of solids must have high values. The applicability of the Ostwald-Hulett formula is limited, since it is based on Van't Hoff's equation for osmotic pressure, which only holds for small concentrations and, therefore, in the present case, for low solubilities.

The growth of large crystals at the expense of small ones occurs, not only in solutions, but also under conditions which resemble even more closely the growth of large drops, *i.e.*, by sublimation. The phenomenon has been observed in the case of sulphur and of sulphur trioxide in an evacuated space, and in the case of camphor crystals condensed from the vapour on a cold glass surface.

(To be continued.)

STRATIFICATION IN MINERAL DEPOSITS.

By W. P. DREAPER, F.I.C.

CERTAIN experiments recorded in this journal (1913, 2, 343) have been continued on the lines then

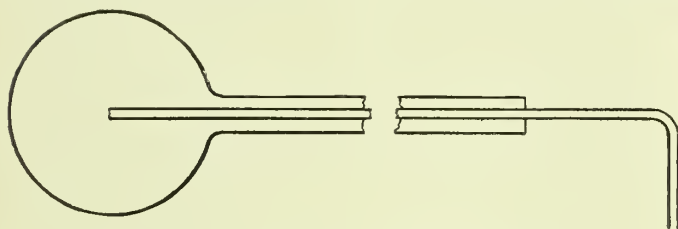


FIG. 1.—CAPILLARY TUBE IN POSITION.

indicated, and extended to the formation of deposits in mineral strata of the nature of kieselguhr or sand.

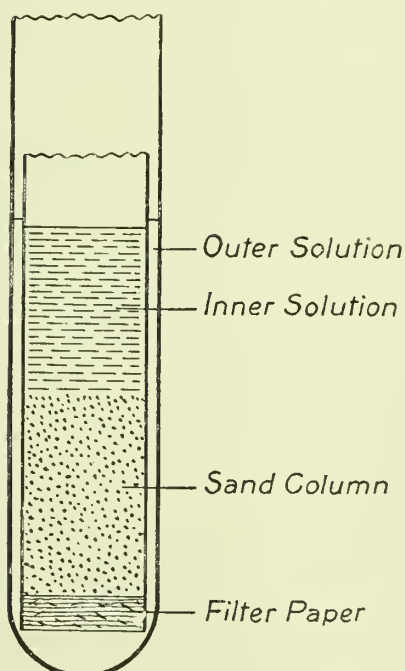


FIG. 2.—MODIFIED TUBE FOR PERMEABLE STRATA.

In these experiments the capillary tube (Fig. 1), as originally used, was replaced by a wider tube of about 5 mm. diameter and 12 cm. in length, which is contained in an outer tube in the manner indicated in Fig. 2.

Under such conditions diffusion may take place in a sand or other similar column under conditions of diffusion which may be controlled as regards temperature, strength of solutions, direction of



FIG. 3.

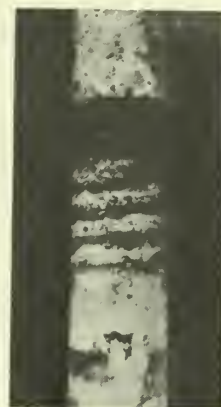


FIG. 4.

flow, etc., details of which have been communicated elsewhere when the results obtained with certain sulphides have been already placed before the Institution of Mining and Metallurgy (February 19th, 1914). In Fig. 3 lead sulphide is seen precipitated in a broad band some way from the outer surface of the kieselguhr. This effect is due to the absorption of the lead from its soluble salt as it passes through the porous area (upwards); so that, although the porous material was saturated with lead acetate solution from below to begin with, the upper area of the same contained no lead salt. Therefore, when the sulphide solution subsequently diffuses down through this upper area, no precipitation of lead sulphide occurs in the upper area of the kieselguhr column.

In Fig. 4 the effect is seen of the control of the incoming sulphide solution under conditions where there is no further flow of the lead solution in the opposite direction. Under such conditions stratification (periodic precipitation) is easily obtained. In Fig. 5 the effect of unequal diffusion is seen with copper sulphide where the column of kieselguhr is not equally dense over its entire area. Here an effect is obtained which might be said to be equivalent to that sometimes observed in natural deposits.



FIG. 5.

Thus these experiments have been extended to porous media of the nature of sand or kieselguhr;

and will now be further extended to denser strata as they exist in Nature, which are sufficiently porous to allow effects to be obtained within a reasonable time.

SOME INTERESTING PUBLICATIONS OF THE U.S.A. GOVERNMENT.

By A. H. MAUDE, A.I.C.

It is somewhat remarkable that this side of the Atlantic the numerous and interesting publications of the U.S.A. Government do not receive more attention, and that their merit is not more fully recognised by English chemists and advanced chemical students. As has been before pointed out in this journal these publications are well worthy of their observation, more especially as they frequently give excellent summaries of the work that has been done in the past as well as an account of the theories underlying the investigations in question, and, what is of importance, one may frequently obtain from them ideas which may develop into further research.

These publications are classified under various headings according to the Government department by which they are issued. It is now proposed to deal with two of them, published by different departments: the first is entitled "Density and Thermal Expansion of Ethyl Alcohol and its Mixtures with Water," by N. S. Osborne, E. G. McKelvy and H. W. Bearce, No. 3 of Vol. 9 of the Bulletins of the Bureau of Standards.

This Bulletin deals, firstly, with the history of the subject, giving an interesting table of the results obtained by various investigators in which the dehydrator used is mentioned and the result obtained calculated to $D_{\frac{25}{4}}^{\circ}$ (by the formula $D_{\frac{t}{4}} = D_{\frac{20}{4}}^{\circ} + (20^{\circ} - t)0.000846$).

The Bulletin next deals with the preparation of pure alcohol for use in the subsequent experiments. It explains that the method of purification should be such that the density of the final liquid is the same whatever the source of the alcohol, and, further, that repeated treatment with the dehydrator should not lower the density. Of the dehydrators tried by various experimenters the most important are CaO , CaCl_2 , active Al (*i.e.*, aluminium amalgam), BaO and CuSO_4 . The conclusion of the authors was that active aluminium or a mixture of barium and calcium oxides was the most effective.

The paper deals simply and well with the theory and practice of detecting traces of impurity in liquids by the method of critical solution temperature, and shows the application of this method to the detection of traces of water in alcohol. The method in question is based on the fact that kerosene and alcohol are partially soluble in each other. If a vessel containing these two substances in two layers is heated, each layer dissolves more and more of the other until they attain the same composition and mix. The temperature at which this occurs is termed the critical solution temperature. Now when the clear mixture is slowly cooled it becomes suddenly turbid at the critical solution temperature, owing to separation of the two components. The critical solution temperature is to a very large extent changed by traces of water. This method is so sensitive that with a temperature determination accurate to 0.05°C . the result would indicate a quantity of water which for its detection would require a density determina-

tion to five places of decimals (such a density determination would require a temperature regulation to within 0.01 to 0.02°C).

The report further deals with the effect of impurities other than water on the density. In this connection it is interesting to note that generally the first fraction of a distillation is denser than the middle fraction owing to the presence of aldehyde in the former. The other impurities considered in this connection are ethyl ether, dissolved air, and higher alcohols. The statement is made that it is impossible to obtain alcohol free from aldehyde as this is produced during distillation, but the quantity thus formed is so small as not appreciably to affect the density determination.

The report now goes on to describe the methods for the determination of the thermal expansion. As this, however, is perhaps of more concern to physicists than to chemists, it need not be entered into here.

On the whole this Bulletin is a fine piece of work and it would be well worth the student's while to read it, if for no other purpose than to see how a systematic piece of research is carried out and how the results are set out.

The second publication selected for consideration in this article is "Notes on Mineral Wastes," Bulletin 47 of the Bureau of Mines, by Charles L. Parsons. This Bulletin, unlike the one previously dealt with, does not describe a piece of research but "embodies the results of certain preliminary inquiries" as to the extent and nature of mineral wastes. In the preface it is pointed out that the present generation will not stint itself to bottle up resources for the future; further, that whatever rights the individual may possess have been derived from the general Government, and that though the individual may claim the right to use the resources in proportion to his needs or the needs of the community, he certainly has no right to waste that which is not needed for present use but may be needed hereafter. So the State should not neglect its duty to its future citizens of doing what it can to prevent the wasteful use of its mineral resources. The first act the State can do with a view to the performance of this duty is to undertake an investigation of such waste with the object of showing how it can be eliminated. Satisfactory evidence is given to show that this investigation and the application of remedies in a businesslike way are really very important problems before the country.

It points out that there are many different kinds of wastes, as, for example, waste in mining (*e.g.*, leaving low-grade ore unworked), waste in concentration, waste in smelting (*e.g.*, waste of sulphur in copper smelting), waste in manufacture, waste as fuel dust or gases (*e.g.*, it is estimated that 10,000 tons of arsenic trioxide are annually thrown into the atmosphere from the stacks in Washoe alone).

It is pointed out that losses are not always realised owing to the lack of or prejudice against technical supervision.

Dealing with the waste of coal, after mentioning that due to the practice of leaving large quantities unworked, and that due to loss of slack, the author states that a boiler deposit $\frac{1}{8}$ in. thick means a loss of 25% in the boiler efficiency; this means the waste of many hundreds of tons of coal annually.

It is pleasing to note that this investigation extends to "economic" as well as material waste. As an example of the former it is remarked that: "Few people realise the immense amount of lubricating oil used, and there is no substance on the market more subject to abuse of brand. For a consumer to pay more than 50% of the selling price for the name on the container is not at all uncommon, and,

as regards the high-priced lubricants, the same oil can frequently be bought on specification for one-third the price that would be paid for it under some special copyrighted name."

A further interesting statement is that, as regards waste, the metallurgy of iron has reached a perfection beyond that of any other metal, and the utilisation of the furnace gases and the manufacture of cement from slag is alluded to.

In the opinion of the writers the metallurgy of copper promises the most profitable research, and they lay stress on the waste of sulphur, arsenic and bismuth as flue dust or gases.

With reference to zinc, probably the most wasted of all metals, it is observed that the methods of its metallurgy are practically the same as were practised in the most primitive times. Only a small proportion of the metal used in the manufactures is recovered, most of it going into galvanised iron, and large quantities being volatilised from open crucibles in brass foundries.

The Bulletin further mentions the waste of tin, cadmium, (concerning which it says that 700 tons were sold as an impurity in zinc during the one year, 1910), antimony, bismuth (it is computed that 4,000 lbs. per day are thrown into the atmosphere in the Western States alone), sulphur, arsenic, certain of the rarer elements, etc.

Consisting only of forty-four pages the, pamphlet necessarily devotes only a short space to each metal dealt with, but it is certain that its readers will look forward to the more detailed reports which are to follow.

A study of the original Bulletins (which necessarily are only very briefly reviewed in the above), or of some other of the publications, which are subsequently to be reviewed in this journal, and which may be of more interest to the reader, would give a clear idea of the methods pursued and of the great field of usefulness which their fuller appreciation would open in this country.

PERSONAL AND OTHER NOTES.

An additional professorship, to be called the Dr. Lee's Professorship in Chemistry, will be established in the University of Oxford, making another step in the reorganisation of the teaching of science in this university.

Professor W. H. Bragg will visit Rhode Island University and will deliver a course of lectures on X-rays and crystals.

The third International Congress of Tropical Agriculture, which will be held from June 23rd to 30th, at the Imperial Institute, is being supported by British, Colonial and Foreign Governments, and by numerous British and foreign associations and institutions. A considerable number of papers will be read on cotton, fibres, rubber, cocoa, and other important tropical products.

Professor Dr. E. Bronnert, director of the branch establishment of the Vereinigte Glanzstoff Fabriken of Elberfeld, at Niedermorschweiler, has been awarded the Medal of Honour by the Société de Mulhouse in recognition of his merits in developing the artificial silk industry in Alsace-Lorraine and his numerous inventions in this sphere.

Professor A. Andonard, President of the Station Agronomique de la Loire-Inferieure, has recently died in his seventy-sixth year. He enjoyed a great reputation on account of his researches in the pharmaceutical and agricultural-technical industries, and was the author of some well-known books, such as "Les engrais" and "Traité de Pharmacie."

Dr. Hermann Rey of Basel has passed away. For twenty-three years he was connected with the Gesellschaft fuer chemische Industrie at this town, and for the last few years he was on the Board of Directors of this concern.

The German Museum in Berlin has been enriched by a most interesting collection of chemical preparations and compounds, which have been produced by German inventors during the last century. The collection consists of 222 specimens which belonged to the Deutsche Chemische Gesellschaft, who exhibited them at the last Paris exhibition in 1900. It is thought that by presenting the collection to the German museum it will be of benefit to students and other interested persons on account of its greater accessibility.

The German Emperor has made a grant of 10,000 marks per annum for the years 1913 to 1917 inclusive for the purpose of continuing the "Illustrated Technical Dictionary in Six Languages," published by R. Oldenbourg at Munich. It may not be generally known that the Verein deutscher Ingenieure (Association of German Engineers) have also granted a sum of 50,000 marks in yearly payments of 10,000 marks for the same purpose, and that the German Handelstag has also obtained substantial sums from different chambers of commerce. At the wish expressed by the Minister of the Interior the dictionary is to be completed within the next five years, instead of within fifteen years, as originally proposed. The first ten volumes have been published by R. Oldenbourg at his own risk and costs.

The second International Convention of Consulting Engineers will take place at Berne on July 16th to 22nd of this year. The committee who were appointed last year at the convention at Ghent will meet for discussion some days previous to the conference, at Lyons. All information on this subject may be obtained by writing to the Fédération Internationale des Ingenieurs Conseils et Ingenieurs-Experts, 18, Rue Marie-Thérèse, Brussels. The next Convention will be held at San Francisco at the end of September, 1915.

Reaction of Tetranitromethane. Professor W. R. R. Hodgkinson (London Section Society Chemical Industry) describes a solvent action in certain metals, *i.e.*, such as form amides or amino-like compounds, of an alcoholic ammoniacal solution of tetranitromethane. When the metal is placed in such a solution a yellow colour develops, the temperature rises and there is a slight gas evolution (N_2) (CO_2). The action only becomes vigorous with copper after a small quantity of the blue cupranine compound has formed. When a cupranine solution is added to an alcoholic solution of tetranitromethane crystals form rapidly. They are identical with those formed from the metal. Similar results were obtained with nickel, zinc, cadmium-amine solutions, and with ammonium double salts of the metals. The salts appear to be of the general type $C(NO_2)_3NHM \cdot 3NH_3$. They are nearly all deliquescent and, when rapidly heated, explode.

REVIEWS OF BOOKS.

"QUANTITATIVE ANALYSIS BY ELECTROLYSIS."

By **Alexander Classen**. Translated by W. T. Hall from the Fifth German Edition. CHAPMAN & HALL, LTD., London, 1913. Pages 308 + vii, with Index. Divided into 4 Parts with 51 Illustrations and 2 Plates. Price 10/6 net.

THE translator has found this last edition so different from the previous editions that this volume contains one, two or three pages of the previous English translation.

This work in its present guise is naturally one which, from its origin, must command attention from all those who find themselves interested in the section of analysis dealt with. The work is divided for convenience into three parts, the first dealing with the theory of the subject, the influence of the electrodes, the effect of rapid stirring, and the influence of temperature on the separation of metals from a complex solution, all of which may have so important a bearing on the efficiency of any special method of analysis by such methods as those considered in this volume.

Part II. deals generally with the processes of electro-chemical determinations, and Part III. with the separation of metals. Part IV. is concerned with the discussion of certain special analyses, such as that of commercial copper, or matte, bronzes, white metals, chrome-nickel steel and copper manganese.

The information contained in this work is essentially of a practical nature, and this will certainly give it additional value, especially to the student, to whom it is obviously addressed.

"THE SYNTHETIC USE OF METALS IN ORGANIC CHEMISTRY."

By **Arthur J. Hale**. J. & A. CHURCHILL, London, 1914. Pages 169 + vi, with Appendices and Index. Chapters VI. Price 4/6 net.

The extended use of the Grignard reaction and the use of metallic sodium and its compounds in synthetic work, as well as the ever extending use of various other metals and metallic derivatives in organic chemistry, make the appearance of this volume opportune. A great deal of useful information is contained in this small volume, and its five chapters and appendices, and the author states that most of the preparations have been carried out in the college laboratory, and have there to this extent been checked. The action of sodium, potassium, copper, silver, manganese, calcium, barium, zinc, mercury, iron, nickel, platinum, aluminium, tin and lead are all considered, and a mere recital of these metals will indicate how widely they have entered in the practical side of organic chemistry.

The author is to be congratulated upon the result of his labour of compilation, which forms in

this book a ready method of referring to the subject under discussion. The practical side of this work is much in evidence, as it should be, and the student generally will find it especially interesting for this reason alone.

"ELEMENTS OF WATER BACTERIOLOGY."

By **Samuel Cate Prescott and Charles Edward Amory Winslow**. Third Edition, re-written. Chapman & Hall, Ltd., London, 1913. Pages 318 + xii., including Index and Appendix. Chapters XL. Price 7/6 net.

The third edition of this work calls for no great attention, except to note that it has received, in its present form, considerable modification, owing to the advance in the subject dealt with during the last five years. The subject treated on is one of considerable importance to most chemists at some time or other, and this work can be recommended as a suitable one for his purpose. The presence of the colon group in water, the varieties of colon bacilli and their special significance, and the bacteriological examination of shellfish, are among the subjects specially considered. The subject-matter is well arranged, and the data included well selected.

"THE CO-OPERATION OF SCIENCE AND INDUSTRY."

By **S. Roy Illingworth**. CHARLES GRIFFIN & CO., LTD., London, 1914. Pages 91 + viii. Price 1/6 net.

This small volume is one which is receiving considerable attention at the present time and its appearance is opportune. As Sir Boverton Redwood points out in his interesting preface, at first sight the need of such a book may be questioned, but that a critical survey of the subject shows that the need is as great as it ever has been. The truth being "that while the great majority of the directors of industrial establishments in this country have been forced to admit the value of the help which science can render, they have not advanced beyond the stage of accepting this view in the abstract, and are apparently as far from applying it in practice."

It is very difficult, in the absence of a census of the manufacturers who actually call in the aid of science, to be quite certain how far this statement is correct.

It will be acknowledged by all, that there is an absence of firms in this country who employ over one hundred chemists, or even twenty; but, on the other hand, the number of those on the Continent or America who do so, is not very large.

Another point which is often missed is that the English manufacturer prefers to engage in a trade or industry where the output in any one article, or substance, manufactured is considerable. That the English method is to aim at a big output, rather than a complicated and miscellaneous one, like the aniline dye trade demands.

There is a good deal of evidence to show that this is correct. For instance, a close consideration of the aniline dye industry itself, will indicate that the English manufacturers have held their own in the case of dyes, like alizarine, which can be manufactured in large quantities; and also in the case of aniline black on cotton, where huge quantities of cloth are dyed, by development on the fibre itself, where this country is far ahead of any other in its output. It may possibly be found that this factor is a very important one. Strangely, it is not one which is often taken into calculation.

The definition given by the author of this book of industry is certainly a happy one, viz., the art of producing from one form of substance other forms for which there is a demand. That its fundamental activity is "concerned with the changing of the forms of matter (or energy?) for pecuniary gain."

The function of the chemist is rightly claimed not to be that of a "magician or a quack," but that he uses his knowledge, which is built up by the best brains of the past, "to cause and direct the production of one form of matter from another."

It is pointed out once more, that the application of science to industry has practically been confined to the last hundred years. If science in its broadest terms is "specialised common sense," this may, or may not be true, just as one decides to regard the nature of empiricism.

The author makes such a point of the aniline dye trade as conducted in Germany, that the figures he gives are interesting. The imports of aniline dyes into this country is given at £1,818,575, for 1912, against an import of £204,475, which he takes as "made here." The value of the textile industry of this country (Census of Production) is £333,000,000 odd. It is acknowledged that the comparison is a loose one, but the relative value of the two figures is sufficiently astonishing to make one wonder whether the aniline dye industry example has not had its day.

None can read this small volume without gaining a clearer idea of the problems which still have to be worked out before the co-operation of science and industry is made complete.

"INTERMETALLIC COMPOUNDS." By C. H. Desch.
LONGMANS, GREEN & Co., 1914. Pages 116 + vi. Price 3/- net.

This carefully compiled monograph on a subject of increasing importance may be safely recommended to all those who are interested in the subject under review. The matter is divided into nine chapters, and is concerned with thermal analysis, microscopic structure, isolation of intermetallic compounds and native intermetallic compounds. Physical properties, such as specific volume, hardness, thermal conductivity, and photo-electric and magnetic properties, are treated at some length.

An interesting chapter deals with the existence of intermetallic compounds in the liquid state. Finally, the relations of the intermetallic compounds to carbides, silicides, and the like, is discussed, and the work is concluded by a chapter devoted to ternary compounds.

The appearance of this monograph will, by focussing attention on this subject, certainly lead to further developments and more definite theoretical conclusions.

BOOKS, ETC., RECEIVED.

"X-Rays. An Introduction to the Study of Röntgen Rays." by G. W. C. Kaye. Longmans, Green & Co., London, 1914. Pages 252 + xix, with Index and Appendices. Chapters XIII., with 97 Illustrations. Price 5/- net.

"A Manual of Practical Physical Chemistry," by Francis W. Gray. Macmillan & Co., Ltd., London, 1914. Pages 211 + ix, with Index, Tables and 61 Illustrations. Price 4/6.

"Molecular Physics," by J. A. Crowther. J. & A. Churchill, London, 1914. Pages 167 + viii, with Bibliography and Appendices. Chapters IX, with 28 Illustrations. Price 3/6 net.

"The Principles of Inorganic Chemistry," by Wilhelm Ostwald. Translated by Alexander Findlay. Fourth edition. Macmillan & Co., Ltd., London, 1914. Pages 836 + xix, with Index. Chapters XLVIII., with 131 Illustrations. Price 18/- net.

"Science Progress." Vol. VIII. April, 1914. John Murray, London, 1914. Pages 802 + iv. Price 5/- net.

NOTES OF MEETINGS.

Chemical Society.

June 4th. G. F. Morrell, "Studies in the Succinic Acid Series." Part I. The Chlorides of Succinic and Methylsuccinic Acids and their Constitution. H. F. Coward and F. Brinsley, "Dilution Limits of Inflammability of Gaseous Mixtures." Part I. The Determination of Dilution Limits. Part II. The Lower Limits in Air of Hydrogen, Methane and Carbon Monoxide. C. R. Crymble, "Comparative Study of the Absorption Spectra of some Compounds of Phosphorus, Arsenic, Antimony and Bismuth." Preliminary note. J. C. Irvine and A. W. Fyfe, "Reactions of β -hydroxy- α -amino-compounds as Cyclic Structures."

June 18th.

Society of Public Analysts.

June 3rd. Alexander Gemmell, "The Insoluble Bromide value of Oils and its Determination." C. O. Bannister, "The Determination of Iridium in Platinum-Iridium Alloys." L. Gowing-Scopes, "The Symbolical Representation of Analytical Operations." L. Gowing-Scopes, "The Properties of some Chlorohydrocarbons and their Uses in Chemical Analysis—Part II." Helen Masters and H. Llewellyn Smith, "The Changes in the Character of Fats during the Process of Cooking." James O'Sullivan, "On the Chief Source of the Loss of Sulphuric Anhydride and of Chlorine by Ashing Substances containing these Constituents."

Society of Chemical Industry.

LONDON SECTION.—June 8th.

Royal Institution.

June 4th and 11th, at 3 p.m. Professor S. P. Thompson, "Faraday and the Foundations of Electrical Engineering."

June 5th, at 9 p.m. Professor W. H. Bragg, "X-Rays and Crystalline Structure."

June 9th, at 5 p.m. General Meeting.

Biochemical Society.

June 11th. Meeting at Institute of Physiology, University College, London, at 5.30 p.m.

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, *Chartered Patent Agent,*
Queen Anne's Chambers, Westminster, S.W.

29305/12. W. A. HALL. **Sulphur.**

A process of producing sulphur from metallic sulphides consists in distilling off part of the sulphur by means of a direct reducing flame applied to the sulphide, removing as SO_2 the residual part of the sulphur by roasting, converting this SO_2 into H_2S , and burning the H_2S in the reducing flame applied to the sulphide.

7107/13. T. R. FORLAND. **Treating Sulphide Ores.**

This improved process for the treatment of sulphide ores, particularly sulphide ores of a complicated nature, with chlorine consists in chlorinating the ore at a temperature at which the metals contained therein, with the exception of gold, silver and the like, are converted into chlorides, and the chlorides volatilised, the volatilised chlorides being separated by fractional condensation.

7233/13. G. H. HARRIS. **Improvements in Concentrating Apparatus for Cleaning, Separating and Classifying Metalliferous Ores.**

7428/13. A. HELBRONNER M. VON RECKLINGHAUSEN AND V. HENRI. **Sterilising Milk.**

A process for sterilising milk consists in first heating the milk for a short period of time at a temperature of from 50°C . to 70°C . and subsequently subjecting the milk to homogenisation and to the action of ultra-violet rays at a relatively low temperature.

7839/13. E. W. ANDERSEN. **Catalytic Reactions.**

For carrying out reactions between a gaseous or liquid body and a gaseous, liquid or solid body by means of porous contact metals as catalytic agents, the metals are employed in the form of Hannover's porous metal.

7987/13. SIR J. W. SWAN and J. A. KENDALL. **Sodium.**

In the manufacture of sodium by condensation from a mixture of its vapour with carbon monoxide, there is used, as a carrier, an easily fusible salt or salts.

8042/13. G. A. H. BINZ. **Improved Process and Apparatus for Determining by Weight Quantities of Gas, Steam or other Vapour or Liquid.**

8279/13. W. A. HALL. **Improvements in the Production of Sulphur from Pyrites and other Metallic Sulphides.**

8758/13. L. STEINSCHNEIDER. **Improvements in Apparatus for Distilling Oils of the Petroleum, Tar and Similar Types.**

9442/13. P. COUPER. **Improved Means and Method of Bleaching the Pulp for the Manufacture of Paper and the like.**

9486/13. A. KOCH. **Purifying Water.**

A process for purifying natural water consists in passing through the water concentrated rays of light in which blue is the predominating colour.

9854/13. THE B. R. S. SYNDICATE, LTD. **Storing Hydrocarbons and Carburetting Air.**

For use in the storage of hydrocarbons and in carburetting air, absorbent blocks or bodies prepared by pressing wood shavings in highly heated moulds and adapted for the transmission of air in the formation of a combustible mixture, are employed.

10288/13. L. F. KAYE and THE BRITISH SILICATE ENGINEERING CO., LTD. **Improvements in or relating to the Manufacture of Bricks, Artificial Stone and similar Products.**

11017/13. WESTINGHOUSE METALLFADEN GLÜHLAMPEN-FABRIK G.m.b.H. **Tungsten.**

A process of rendering tungsten ductile and malleable consists in heating the metal by embedding it in a mixture which reacts exothermically, igniting the mixture and causing the molten mass to cool slowly.

11612/13. E. V. PEARCE. **Tin Ore Treatment.**

This process for the treatment of tin ore or concentrate, consists in heating the material (with or without the addition of sulphur) in a closed furnace without the admission of air to such a temperature that the sulphur reacts with the metallic impurities and converts them into an acid soluble condition.

13309/13. H. CASSARD. **Shellac.**

In the process for refining shellac and its allied lacs, which uses two solvents, namely, an alcoholic solvent for the lac and a hydrocarbon solvent for the wax, the novel step of treating the material at a temperature at or above the melting point of the wax, *i.e.*, from 57°C . to 84°C ., is employed.

15300/13. K. KUBIERSCHKY. **Distilling Mineral Oils.**

In that process of distilling mineral oils by means of superheated steam in which the distillates are condensed after imparting their latent heat to the raw material and superheated steam which has been utilised for the process being again superheated and then returned to the distilling chambers, part of the superheated steam is withdrawn from circulation in front of the superheater and fresh steam substituted for this part.

17307/13. T. HAWKINS. **Improvements in the Manufacture of Explosives of the Sprengel Class.**

20189/13. VEREIN CHEMISCHER FABRIKEN IN MANNHEIM. **Improvements in, and Apparatus for, the Distillation of Nitric Acid or Nitric Acid Monohydrate.**

20942/13. J. SCHECKENBACH. **Fusel Oil.**

This process of producing fusel oil by means of bacteria, consists in subjecting the base substance to the action of "heat-proof" bacteria.

21366/13. SOCIÉTÉ GÉNÉRALE DES NITRURES. **Process for the Manufacture of Nitrides such as that of Aluminium.**

21478/13. W. H. HOFMANN. **Deodorising Oleic Acids.**

This process for deodorising oleic and other fatty acids derived from train or fish oils consists in sulphonating the said acids in the presence of resins.

21771/13. F. RIPEAU. **Rubber Treatment.**

A process of smoke curing rubber latex consists in repeatedly performing the following operations (a) pouring sufficient latex on the external longitudinal surface of a drum to give a complete but thin coating thereto, (b) rotating the drum to distribute the unsmoked latex evenly and (c) thereafter subjecting the coated drum, whilst still rotating it, to the action of smoke.

22647/13. G. BUCHNER. **Softening Water.**

A composition for softening water comprises di-sodium phosphate in combination with borax.

22825/13. O. TOEPFER. **Sterilising Wood.**

A method of sterilising wood and expelling the natural sap consists in exposing the wood in quick succession to the action of saturated steam, cold water, sudden vacuum and a drying medium.

25715/13. MASCHINEN-UND WAGGONBAU-FABRIKS AKTIENGESELLSCHAFT and F. R. VON SUESS. **Purifying Water.**

A process of purifying water consists in passing the water first through a filter of fibrous material, then through a filter of stone, sand or earthenware and lastly through an ultra-violet radiation steriliser.

528/14. K. TARASSOFF. **An Improved Process for Manufacturing Condensation Products from Phenol, Formaldehyde and the like.**

1039/14. PERMUTIT AKTIENGESellschaft. **A Method of Manufacturing Base-exchanging Substances containing Silica, Alumina and Bases.**

ENGINEERING NOTES.

By R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

Suitability and Conversion of Mill Driving.

On April 24th last a paper was read before the Institution of Mechanical Engineers by Mr. Rothera on a subject connected, indeed, with metallurgy, but, on the face of it, quite remote from chemical engineering, *i.e.*, "The Electrical Driving of Rolling Mills."

Many of the conclusions brought forth in the paper, however, and many of the points made in the subsequent discussion, are of sound general application, and have as much bearing on chemical factories as many others.

The first sentence of the paper, contains a problem which all established works have to grapple with continually: the difficulty of competing with new mills, backed by courage and capital and laid down on a foundation of other people's experience.

The author, who is clearly in favour of electrical driving, began by making what he considered four outstanding points in its favour: economy of running, improved drive, space considerations, and greater use of existing plant.

The first point is not a very strong one, except in the case of large corporations, or works by the nature of their trade or geographical position very favourably placed, for, as a rule, unless water power or otherwise wasted blast furnace gases are easily available, no moderate-sized works in the neighbourhood of a large town generating station can compete with the price of local supply.

The above considerations, which apply with most force to works recently or about to be set down, are considerably modified when the works have been in operation a long time, and what was once a fairly compact steam-driven plant has become a sprawling meshwork of leaky and radiating steam leads to engines now usually somewhat overloaded. In a case such as this, where steam might be cheaper than electricity on a new works, greater convenience and enormous reduction of losses may make conversion a thoroughly sound step.

A further economy is due to the vastly greater overloads electrical drives will take for short periods with but a small fall in their efficiency and the decrease in the number of attendants required.

The second point is a good one where a uniform torque with but a small drop in speed is of great advantage, for in steam practice only a very large fly-wheel will secure this, and even then a high-powered engine is necessary if the overload is at all sustained—this makes for very uneconomical running at ordinary loads. This point is not such a strong one, however, to most chemical factories, for there, as a rule, while overload capacity is always of value, even turning moment is seldom of great importance.

The third point, especially where land is dear or area

restricted, as in most manufacturing centres in this kingdom, is by far the most important; a motor, exclusive of gearing, will usually occupy between a sixth and a tenth the space required for the same power of steam engine, quite apart from the necessary boiler plant and other auxiliaries. These facts render the conversion of steam to electrical driving in towns a point of the greatest interest where it is desired to considerably increase the ground space output of the factory.

The fourth point of increased power, when taken in conjunction with the last-mentioned one, practically makes itself, for space can be saved and power greatly increased at a moderate cost, and neither the one nor the other can be done by putting down a much larger engine.

Before deciding to convert from one source of power to another, however, a very careful consideration of the actual saving likely is necessary, and also of the interest and amortisation charges due to any plant which may be installed to effect the change, and these very important points are sometimes unfortunately completely overlooked by enthusiasts for conversion.

Impervious Concretes.

Now that the cheapness and strength of armoured concrete structures are so well established, and the suitability of this method of construction has been found so great for silos for corn, nitrolim, and a great variety of products, the storage and quick loading of which are essential factors in their price, a good deal of thought and money have been expended in attempting to make storage reservoirs of this material to contain various liquids usually under a fair static head.

Unfortunately concrete is usually far from impervious to water at quite moderate heads, and to a great many other liquids is extremely unsuited, and on this account various oil-mixed concretes have recently been introduced, partly as coating for water-containing storage, and partly for the storage of other products, such as those formed by the distillation of tar. Some oil-mixed concretes are now on the market which are said to be capable of withstanding a static water head of 40 lbs. to the square inch, but the writer has not heard of any structure of this kind which has served its purpose for a long enough time to show what was the effect on the concrete of its, in these cases, principal constituent, the oil. In the *Proceedings of the American Society of Civil Engineers* for 1913, 39, 355, an account appears of the recent researches of Messrs. Taylor and Sanborn into this subject, using asphaltic oils in the mixing of the concrete aggregate, and the question was specially attacked from the "permeability under pressure" point of view. The results with this type were far from encouraging.

Concrete containing 5 to 15% of oil, by weight of cement, were found to be more permeable when subjected to pressures of 20 to 60 lbs. to the square inch than concretes mixed without oil, while the general strength of the concrete was found to be very adversely affected by the addition of quantities of oil even below 5%.

The lighter oils, however, at low static water heads, seemed to somewhat decrease the absorptive powers of the concrete for water, but with the heavier oils the concrete appeared again to be more absorptive than when mixed without water. In the *Proceedings* referred to the method of conducting the tests is fully described. Chemically oil of any sort does not seem to be suitable in use with concrete, and the writer would be interested to know if the deposition of some base metal on a suitably prepared concrete surface could not be achieved to meet this difficulty.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

A Cheap Fire Extinguisher.

Experiments conducted at a varnish manufactory in Connecticut are stated to have demonstrated that sawdust is of considerable value in extinguishing the fires frequently arising in varnish-making plants. Seventeen experiments were made altogether, of which the following are typical: Varnish to a depth of 2 ins. was ignited in a steel vessel. The fire was extinguished in 25 seconds with two and a half shovelfuls of sawdust. Ignited varnish to a depth of 4 ins. was extinguished in 10 seconds with a quarter of a shovelful of sawdust mixed with sodium bicarbonate. Nearly three gallons of varnish ignited in a pine tray 5 ft. square were extinguished in 53 seconds with three shovelfuls of softwood sawdust. A fire in a steel vessel containing petrol to a depth of 2 $\frac{3}{4}$ ins., which was not affected by four shovelfuls of sand, was afterwards put out in 56 seconds by eight shovelfuls of sawdust. The efficacy of sawdust is attributable to the fact that the material floats on the ignited surface and protects it from air.

Adulterated Cocoa Butter.

An attempt has been made recently to put adulterated cocoa butter on the market. Unlike similar preparations, this cocoa butter does not represent the fat pressed out from the cocoa bean, but is a fat obtained from the cocoa waste by means of chemicals. The *Gordian*, in commenting on this, says that the designation extracted cocoa butter is wrong and misleading. The objectionable smell of the product is a great drawback, although it might prevent the use of the adulterated stuff in the food industry. It might, however, be profitably employed for technical purposes.

Pottery Glazing without Heat.

A German inventor has recently taken out patents in several countries for an enamel substance which is claimed not to require heat to produce the glaze on pottery ware. The articles are submerged in the mixture, and, after being in contact with it for a certain time, are taken out to dry, and the glazing is accomplished. It is stated that the substance is made by thoroughly mixing three parts of glowing magnesium oxide of a specific gravity of 3.0 with four parts of the saturated cold watery solution of magnesium chloride. To this mixture is added a solution of shellac, mastix or sandrac gum in alcohol in the proportion of 25 : 100.

Artificial Sponges from Leather.

The *Revue de Chimie Industrielle* quotes a new employment for leather waste which is rather unusual. It is paste for making artificial sponges. This paste consists in a mixture of degreased leather fibres, preferably sole leather, finely shredded and mixed with liquid indiarubber as a cement. The paste is filled with holes or pores, and, because of the cohesive strength of the fibres, it is capable of absorbing and retaining a large quantity of liquid.

The preparation of sponges from the fibres is described as follows: from thirty to eighty parts by weight of leather fibres are degreased by the usual method; they are then saturated with a thick sulphur-milk and allowed to dry. When dry the fibres are placed in a mixture of from twenty to seventy parts by weight of liquid rubber and carbonate of ammonium, so that the fibres are saturated and covered by the mixture, which forms a resistant mass, which can be shaped in the form it is desired to have the sponges. The mass is then warmed, preferably in a vacuum, at first gently, raising the temperature gradually to about 260 to 300°. During this time the carbonate of ammonium is liberated, and the gas, after causing the formation of a great number of pores and passages in the surrounding mass, finally escapes. The porous and resistant mass, prepared as stated, is vulcanised by the sulphur that was deposited by the sulphur-milk on the leather fibres, thus rendering it sufficiently elastic.

To facilitate the escape of any gas that might be enclosed in the vulcanised mass, the piece is pressed, when cold, against a surface covered with fine needle points, which permits the gas contained in the enclosed pockets to escape through the punctures. The sponges may be coloured any shade desired.

The German Potash Syndicate at the Panama Exhibition.

According to the *New Yorker Handels Zeitung*, the resolution of the German Reichstag to make a grant of 500,000 marks to the Potash Syndicate, in order to take part in the World's Exhibition at San Francisco, has made a very good impression in the United States. The grant is sufficiently high to enable the syndicate to be well represented, and it is hoped that the show will attract much attention.

The International Exhibitions of Chicago and St. Louis have also been the occasion for excellent displays by the German Potash Syndicate. As the countries along the Pacific coast, with their highly developed fruit growing and agricultural industries, seem to offer special opportunities for the sale of potash, the Syndicate are convinced that any efforts to foster the trade in these regions will be fully rewarded.

Wood Alcohol Legislation in the United States.

For the purpose of safeguarding the public against injury through internal or external use of wood alcohol, a member of a prominent American drug firm has effected a re-introduction before the New York City Board of Aldermen, in a slightly amended form, of the wood alcohol ordinance Bill which was vetoed by Mayor Gaynor last year.

The provisions of this measure prohibit the sale of wood alcohol except under the name of "wood naphtha," and its use in any medicinal or toilet preparation. They also provide for a compulsory labelling of the spirits with a poison label, and with a warning to be printed in red letters on a white background to the effect that the internal use of the fluid is likely to produce blindness and lead to death.

It is expected that considerable opposition will be raised against this Bill by distillers and wholesale chemists.

Examination of Gelatin in Canada.

The Inland Revenue Department gives the results of the first systematic examination of gelatin. No satisfactory definition of gelatin as distinguished from glue has been published. Ash of high-grade gelatins should not exceed 2%. The ash exceeded this amount in sixty-eight samples examined, but it did not reach 3% in any sample. The sulphurous acid varied from a trace to 1,090 parts per million. It is certain that this last figure is excessive. In a number of gelatins the presence of vegetable dyes and aniline was disclosed. It is explained in the bulletin that gelatin enters largely into various jelly powders, crystals and blocks, also into tinned and potted jellied meats and as a stiffener in ice-cream. The following paragraph is interesting: "By the use of known methods of refining, bleaching, etc., it is possible to make a very attractive article of gelatin from the most objectionable raw material. Nor does it follow that analytical processes applied to the finished article must certainly discover the nature of the original substances used. Notices of the composition of commercial gelatin in the United States as being filthy, putrid material, or as being plain glue, or as containing arsenic and zinc, are referred to as proof that commercial gelatin may be an objectionable food substance."

A Central Organisation for the Sale of Chile Nitrate.

Negotiations have been proceeding in Hamburg with a view to the formation of a central organisation for the sale of Chile nitrate, but the *Frankfurter Zeitung* states that the discussions have not led to any result. From the beginning of the negotiations, in which English interests also participated, the German circles concerned with the trade adopted a sceptical attitude towards the scheme. Apparently producers have endeavoured to secure a more remunerative return by the organisation and centralisation of the sales business, by the exclusion or limitation of the merchants, importers and brokers, who were kept away from the negotiations. It is now proposed by those promoting the scheme to continue the efforts by way of written communications. The Frankfort newspaper remarks that Chile nitrate for the fertilisation of the soil no longer occupies the dominant position of former years, as apart from the increasing output of sulphate of ammonia, the Chile commodity has to reckon with the products of the artificial nitrogen industry in the form of cyanamide and nitrate of lime, the rivalry of which will become greater the higher the prices for Chile nitrate are fixed.

Source of Ammonia in Rain Water.

Systematic analyses have been made for a number of years of the amounts of ammonia and nitrate in rain. The question was at one time of great interest in connection with nutrition of crops, Liebig having maintained that plants derived a considerable proportion of their nitrogen from this source. The analyses have long disproved this view, and interest has now turned to another problem—the source of the ammonia invariably found in the rain water. Samples of rain have been collected systematically from various stations in the Hebrides and in Iceland, remote from atmospheric pollution, in order to ascertain how the amounts of ammonia and nitrate compare with those found at Rothamsted.

All the samples contain ammonia and nitrate, although the amounts are low. Indeed, those from the Butt of Lewis, 0.666, and Vifilsstadir, 1.065, are the lowest hitherto recorded, the amount of ammonia in the Butt of Lewis rain, 0.361, being even less than was found in the southern regions by the Charcot expedition. Seeing that ammonia is always present, it is important to ascertain its origin. The older theory that atmospheric ammonia is derived from the sea, and the more recent one that tropical seas give up ammonia to the air, are not supported by any analyses of rain collected near the sea in tropical countries. The only possible explanation seems, according to the latest investigation, to be that the soil, or, at any rate, arable soil, is continually giving up some of its ammonia to the air. So that, instead of the rain contributing 3 or 4 lbs. to the acre, it seems more probable that it is merely restoring some portion of the ammonia which the soil had previously lost.

Cases of Poisoning in a Russian Indiarubber Factory.

The largest Russian indiarubber goods factory, belonging to a Russian-American concern trading as "Treugolnik," and situated in St. Petersburg, has recently been the scene of a remarkable occurrence. It appears that in the overshoe department of the factory some 200 girls, who were using a new cement for sticking the different parts of the goloshes together, had fainting fits. These were evidently caused by inhaling the poisonous fumes given off by the new substance for cementing. It is said that this substance was a solution of chloroform and petrol which, in evaporating, gives off fumes causing faints, hysteria, and epileptic fits. As one can easily imagine, the occurrence has caused great consternation among the workers, who demanded the complete destruction of all the offending material, and refused to continue their work unless their request was granted. This led to trouble between the police and the workpeople, and in the skirmish several persons were hurt.

Dye Compounds for Destroying Diseased Organisms.

Dr. Karl F. Meyer, Associate Professor of Bacteriology and Protozoology at the University of California, has recently recorded a new discovery that dye compounds are capable of destroying disease organisms in the human body without injury to the patient.

A New Industry in New Zealand.

What promises to become an important and lucrative industry, viz., the manufacture of sugar of milk, has been introduced into New Zealand. The originators of the undertaking are two chemists who thus endeavoured to fully utilise the by-products of the large dairying industry in this country. The principal consumers of the product will be the brewing industry and the householders, the latter using sugar of milk to sweeten baby's milk and food in preference to ordinary sugar. In view of the enormous development of the butter and cheese industry of New Zealand, it is difficult to over-estimate what the introduction of this new industry may ultimately mean to the farmers.

Canadian Forest Products Laboratory.

The Dominion Government has decided to establish a forest products laboratory at McGill University, Montreal

owing to the great increase in the Canadian pulpwood and paper industry. This will be conducted in connection with the Department of Chemical Engineering.

M. L.

CONSULAR AND OFFICIAL REPORTS.

Growing Consumption of Fertilisers in Japan.

The American Consul at Yokohama reports a considerable increase in the use of fertilisers by Japanese farmers. In 1913 the aggregate used of such fertilisers, of a value of \$34,418,115, was a gain of nearly \$10,000,000 over the preceding years. The most important items in the consumption of fertilisers during last year were bean-oil cake, phosphate rock and sulphate of ammonia. These items in their relative use, by values, were: bean-oil cake, \$16,700,000; sulphate of ammonia, \$7,964,000; and phosphate rock, \$4,291,000.

Lignite as Fuel.

From time to time the possibilities of lignite as fuel receive attention, but no great commercial success has been achieved. His Majesty's Consul at Chicago now reports, however, that, in view of the enormous deposits of lignite available in various States, and the fact that in North Dakota all State institutions are required by law to use lignite, the university of that State has been conducting experiments with this fuel. It has been found that 1 ton of lignite in a gas producer will yield as much horse-power in ordinary combustion engines as 1 ton of the best bituminous coal under steam boilers. The problem, however, is to find a means of handling lignite so that it may be easily transported. In its raw state it disintegrates when exposed to the air, and has not been used at points very far from the mines. Experiments have shown that the manufacture of briquettes is generally impracticable without some sort of a binder. Where such binder is used the large amount of moisture lignite contains is evaporated, and the fuel is correspondingly improved in heat value. The briquettes are non-coking, and do not form clinkers; they are easy to handle, and provide an even fire on the grate.

Free Admission of Chemical Fertilisers into Belgian Colonies.

Under a royal decree of the present year provision is made for the free admission into Belgian colonies of organic and chemical fertilisers. In the tariff of Belgium fertilisers are all on the free list.

Fertiliser Trade in the Canary Islands.

The Commerce Department at Washington have received a report on the trade in commercial fertilisers in the Canary Islands. The demand for this commodity in the islands is very great, and the importation, chiefly from the United Kingdom, increased from about 8,500 tons in 1910 to more than 14,000 tons in 1912, and the figures for 1913, not yet completed, will show an increase of more than one-third over the 1912 figures.

The report concludes as follows: "The striking fact about the imports of chemical manures is that so large a proportion comes from England. Chilean nitrate, German potash, phosphate from Florida and Morocco, as well as blood from Chicago and Buenos Aires, all are purchased in a country which produces little or none of them; but, as may be seen from the import statistics, the British predominance

is becoming less marked every year. Sulphate of ammonia 20—21% nitrogen, is largely used in the islands. It is imported principally from England, and in smaller amounts from Germany, Belgium and Holland. Guano is not used as much as formerly, the worthlessness of some articles sold under the name and the high price of the better qualities having destroyed the demand. Nitrate of soda, the product of the Chilean fields, containing 14 to 16% nitrogen, is bought almost exclusively in England.

ALCOHOL MOTOR FUEL.

The following are the Members of the Committee of the Imperial Motor Transport Council: Mr. Arthur Stanley, M.P. (Chairman), Mr. Thos. L. Aveling, Lieutenant-Colonel Sir Chas. H. Bedford, Mr. Bertram Blount, Mr. J. Sidney Critchley, Mr. S. F. Edge, Mr. Rupert W. Ellis, Mr. S. Glover, Dr. H. S. Hele-Shaw, Mr. Basil H. Joy, Professor Vivian B. Lewes, Dr. W. R. Ormandy, Sir Boverton Redwood, Mr. Sidney Straker, Mr. Thomas Tyrer, and Mr. Horace Wyatt (Hon. Secretary).

MARKET REPORTS.

LONDON.—A comparison of the April statistics of the British imports and exports of chemicals with those of the same month of last year are misleading, and must not be taken as a guide to the true state of affairs, as the loss of the Easter holiday period during last April is responsible for a great part of the decrease which took place, both in imports and in exports. The set-back in the exportation of chemicals, drugs, dyes, and colours, has been quite considerable which was largely due to diminished shipments of coal products (other than dyes). The value of these fell from £289,789 in April 1913, to £199,347 last month, a drop of nearly £100,000, while chemical fertilisers showed an even greater decrease, viz., from £459,942 to £350,159. An interesting, though hardly very gratifying fact is the increased importation of soda compounds, which amounted to 20,458 cwts. of a value of £18,770, as compared with 15,653 cwts. (£14,344) in April, 1913. At the same time, the exports of this class of commodity have gone down from 733,449 cwts. (£169,591) to 582,154 cwts. Copper sulphate shipments were rather better than expected, amounting to 18,372 tons, a decrease of only 78 tons, though the total for the first four months declined by about 10,000 tons.

The home trade has not experienced any decided revival, so that there is no lack of complaints among the merchants and manufacturers. The business in fertilisers has further slowed down, causing the tendency to favour buyers. Large stocks of nitrate on the Continent and moderate demand have caused a slight weakening of the prices which are, however, still a little higher than those at Hamburg. The supplies are more than sufficient to satisfy the shrinking demand, and there are no signs of an immediate improvement. The nominal quota for refined nitrate of soda is £11, and for ordinary quality £10 10s., but it would be possible to buy under this price. The chances for a revival of trade in sulphate of ammonia, as far as this season is concerned, seem to have vanished. The market is extremely slack, buyers confining themselves to insignificant parcels for prompt delivery. There is no interest for forward business, though makers might be ready to make some concession on the price for early delivery which stands at £11 5s. for grey 25% sulphate. The production in the

United Kingdom, on the Continent, and in the United States is growing apace. The section for tar products evokes many complaints from dealers and makers. Pitch has come down to about 35s.—36s., without causing consumers to come forward. The producers have not given up their expectations of better prices, which are based on the probability of a larger demand for road-making purposes, but besides this slender possibility, there are no grounds for believing in higher prices. The business in benzol has suffered from the uncertainty as regards the Budget, and although the anxiety has now been relieved, the quiet feeling remains. The Continental demand for benzol has been very unsatisfactory. The price for small quantities keeps in the neighbourhood of 1s. per gallon, but large orders could be placed at a lower rate. Carbolic acid remains very quiet at about 1s. 1d. for crude 60's, while crystal is 3½d.—3¾d. The fact that German makers are prepared to sell crystal at 3d. per lb., makes it difficult to persuade buyers to pay the prices asked by our manufacturers. Naphthalene is regularly inquired for, and all available quantities pass rapidly into consumption. Fair to fine qualities realise 55s.—87s. per ton, while refined sell at £7 10s.—£10. Creosote, too, has no difficulty in maintaining its price, viz., 3½d. per gallon. Acetate products, such as acetic acid, acetate of soda, etc., have recently all been sold at very low prices, and as there seems no room for further reductions, present rates are considered attractive. Bichromates of potash and soda move fairly well at unchanged values. The demand for alumina products from home and export buyers keeps up well.

MANCHESTER.—Heavy chemicals are moderately inquired for, although the export demand cannot be called active. The recent upward movement of citric acid has further developed, and the price has gone up to 2s. 4¾d. per lb. Tartaric acid remains scarce, and is, therefore, firmly held at 1s. 2d. per lb. Sulphate of copper attracted little attention, causing a weaker tendency. Unless the metal firms up, the depression will probably last for some weeks, as the active season is now at an end.

LIVERPOOL.—Business in chemicals has slightly revived. The demand for ammonia alkali remains good, but makers complain of the very low prices which the buyers are inclined to pay. Soda ash (ammonia alkali) is obtainable at £2 17s. 6d.—£3 10s. per ton f.o.r. at works, and at £3 16s. per ton in softwood casks for shipment. Chloride of calcium is fairly active. The closing quotation is £2 7s. 6d.—£2 12s. 6d. per ton, in drums, f.o.r. at works. Bichromate of potash sells readily at 3½d. per lb. The inquiry for bleaching powder from the cotton trade has improved, though paper makers are rather reluctant buyers. The spot price is £5 7s. 6d.—£5 15s. per ton, in 6 to 8 cwt. softwood casks f.o.r. at works.

GLASGOW.—The trade in chemicals has taken a turn for the better since the uncertainty about the Budget has been removed. Several commodities are very firm and scarce. This refers particularly to citric acid and tartaric acid. Cream of tartar tends also upward, whereas coal tar products remain quiet and more or less weak.

Metal Markets.

LONDON.—The copper market is entirely influenced by the situation in America. The uncertain outlook for the peace negotiations does not favour speculative activity, but on the other hand, it must not be forgotten that the present prices are low, and a resumption of buying for American account would quickly strengthen the tendency. Standard

copper is quoted at £63 7s. 6d. for cash, and at £63 12s. 6d. for three months' delivery. Trading with consumers has been very quiet. Manufactured copper is neglected, and the price of strong sheets has gone down to £78. Dealings in tin have been very active. The recent attempts by bears to check the upward trend of prices by aggressive forward selling, having ceased, the prices have once more recovered sharply. America has not been buying much, but consumers seemed more inclined for business. Cash tin sold at the close at £154 15s., and three months' delivery at £156 10s. Lead was fairly active, and forward positions favoured sellers on account of small offering and good demand. Although last month's imports were the heaviest for nearly two years, the total for the first four months of the year exceeds last year's by 3,800 tons only. Soft foreign lead sold at £18 10s. for June, and at £18 for August delivery, while English lead is held at £19. Spelter remains dull and weak. The surplus of the Syndicate has increased to over 80,000 tons, but the restriction of output now taking place should help matters. G.O.B. prompt is quoted at £21 6s. 3d.

FINANCIAL ITEMS.

Liebig's Extract of Meat Co. will distribute final dividend on the ordinary shares for 1913 of 10% (being 10s. per share) together with a bonus of 2s. 6d. per share, both free of tax, payable on and after June 15, making a total distribution for the year of 22½%.

The profits of Brunner, Mond & Co. for the year ending March 31 amounted to £769,344, making with the amount brought forward a total of £889,522; a dividend on the ordinary capital, making 27½% for the year, is proposed subject to deduction of tax and of the amount paid on December 12, also to write £2,500 off patents account, and to carry forward £110,921.

The Castner-Kellner Alkali Co., Ltd., have declared an interim dividend for the half year ending March last of 5%, including bonus shares.

The British Cotton and Wool Dyers Co., Ltd., have declared a dividend of 5% for the past year on the ordinary shares.

Sanitas, Ltd., have declared a final dividend of 5% making 7½% for the year, placing £3,000 to reserve, £1,000 to contingency fund, and carrying forward £2,757. The dividend is the same as for the three preceding years.

Fullers Earth Union. The revenue account for the year shows a balance of £13,445. A dividend of 10% on the ordinary shares, making 15% for the year, is to be paid, and £15 per founder's share is also to be paid. Last year the ordinary shares received 14% and the founder's shares £10 a piece.

Cassel Cyanide Co. Interim dividend of 1s. per share, free of tax, the same as last year.

The old established firm of Farbwerke vorm. Meister Lucius and Brüning at Höchst-on-Main have again had a fairly successful year, in spite of several unfavourable circumstances, such as higher tariff rates in the United States, political unrest in South and Central America, etc. The capacity of the works has been increased by installing modern machinery and modernising the plant generally, which also helped to reduce working costs. The gross profits were 16,383,417 marks (18,607,907), and the dividend has been fixed at 30%. The capital has been raised by 14,000,000 to 50,000,000 marks.

Bremen.—Behring-Werke G.m.b.H. in Bremen und Marburg is the title of a new limited company which has

been registered with a capital of 675,000 marks. The object is to carry on the manufacture of therapeutic compounds.

Basel.—The Chemische Fabrik vorm Sandoz at Basel proposes to again pay a dividend of 14%.

Mayance.—The gross profits of the Verein fuer chemische Industrie for last year increased by 380,000 marks, and the net profits rose by 244,000 marks. This enabled the directors to pay a dividend of 22%, as against 20% for 1912. As the firm will celebrate their fiftieth anniversary in 1915, a reserve has been created amounting to 125,000 marks for the purpose of gifts and distributions. The net profits reached 1,474,674 marks (1,230,046) on a share capital of 3,600,000 marks.

Berlin.—Chemische Fabrik Goulson & Co. G.m.b.H., Berlin-Schoeneberg, has been incorporated with the object of manufacturing and selling chemical compounds. The capital of the company is 20,000 marks.

Copenhagen.—A new company which will engage in manufacturing chemicals has been formed under the title of Aktieselskabet Oxhydric. The capital of the concern is 56,000kr.

The chemical manufactory under the management of O. Scholin-Borg at Helsingborg has been completely destroyed by fire.

The Norwegian saltpetre firm of Société Norvégienne de l'Azote have considerably increased their production during last year. Their works at Svålgefoss and Notodden are working with 55,000 H.P., and those at Rjukan with 120,000 H.P., so that their capacity may be estimated at 100,000 to 120,000 tons per annum. By 1916 it will probably have risen to 160,000 tons. An interesting fact is the efforts of the concern to extend their influence over Portugal and Spain. The Soc. Iverica del Azoe has recently obtained a working concession from the Norwegian firm for which the former paid 1,000,000 francs, and certain royalties on the production. They intend starting work as soon as the factory at Lérida is finished.

Nuremberg.—Bayerische Zelluloidwarenfabrik vorm, A. Wacker A.G. at Nuremberg have increased their sales from 594,259 marks in 1912 to 649,641 marks in 1913, but their net profits rose from 124,110 marks to 161,003 marks only. The dividend will, however, be the same as in 1912, *e.g.*, 9%. The carry-forward is 27,045 marks (26,222).

Rennersdorf, near Vienna.—Dr. Rudolf Stern, G.m.b.H. is the title of a new limited company, the object of which is the manufacturing and sale of chemicals, particularly colours and fillers for the indiarubber industry. Dr. Rudolf Stern, chemist, of Vienna, is the general manager.

W. J. Bush & Co., Ltd., the manufacturing chemists and drug merchants, report a falling-off in net profits, the net surplus for 1913, after providing for depreciation and debenture charges, being £40,600, as against £45,300 for 1912. While the dividend is maintained at 12%, and the contribution to the reserve fund at £15,000, and while nothing is written off plant and machinery, against the depreciation of which £4,000 was provided out of the net revenue of 1912, the carry-forward is £4,400 higher at £29,200. The reserve fund now amounts to £80,000. The agreement between this company and W. J. Bush & Co., Incorporated, of America, approved by the shareholders at the last annual meeting, has been duly carried into effect by re-incorporating the company under the laws of the State of New York.

The New Transvaal Chemical Co., Ltd.—An interim dividend at the rate of 6% per annum for the half-year ended December 31st, 1913, has been declared on the issued preference shares.

NEW COMPANIES.

BENNETTS of GRIMSBY, LTD.—Capital, £10,000. Object : To carry on the business of fishmeal, manure, glue and chemical manufacturers, bone crushers, soapmakers, manufacturers of products from fish, etc. Registered office : Pyewipe, West Marsh, Grimsby.

MOTOR BENZOLE Co., LTD.—Capital, £2,000. Object : To take over the business carried on by A. C. Lucius and A. E. Stanton as the Motor Benzole Co., to carry on the business of manufacturers of refiners of and dealers in benzole, petrol, and motor spirit, paraffin oil, grease, and lubricants, etc. Registered office : 196, Deansgate, Manchester.

SADLER & Co. (GLASGOW), LTD.—Capital, £20,000 in £1 shares. Object : To carry on business as manufacturers of and dealers in soap, candles, tallow, etc. Registered office : 101, Colvend Street, Glasgow.

SHARE LIST.

Name of Company.	May 24th.	April 24th.
Alby United Carbide	117 1/2	117 1/2
Ditto. Pref.	13 1/2	13 1/2
Associated Portland Cement. (10)	58 1/2	58 1/2
Ditto. Pref. (10)	8 1/2	8 1/2
Babcock-Wilcox. Ord.	21 1/2	21 1/2
Ditto. Pref.	11 1/2	11 1/2
Bell's United Asbestos	1 1/2	1 1/2
Bleachers' Association. Ord. ..	3 1/2	3 1/2
Ditto. Pref.	1 1/2	1 1/2
Borax Consolidated. Pfd. (5) ..	5 1/2	5 1/2
Ditto. Defd.	2 1/2	2 1/2
Ditto. Pref. (10)	11 1/2	11 1/2
Bradford Dyers	1 1/2	1 1/2
Ditto. Pref.	1 1/2	1 1/2
British Oil and Cake. Ord. ..	1 1/2	1 1/2
Brunner Mond. Ord.	4 1/2	4 1/2
Ditto. 7% Pref. (10)	15 1/2	15 1/2
Bryant and May. Pref.	2 1/2	2 1/2
Calico Printers	3 1/2	3 1/2
Ditto. Pref.	3 1/2	3 1/2
Castner Kellner	2 1/2	2 1/2
Commercial Salt. (2/-)	7/-	7/-
Crossley & Sons. (2)	11 1/2	11 1/2
Ditto. 5% Pref.	4 1/2	4 1/2
Eastman Kodak. (\$100)	525	575
Eley Brothers	1 1/2	1 1/2
Fraser and Chalmers. (£3)	101	101
Gas Light and Coke. (S.)	96	99
Ditto. 4% Pref. (S)	3 1/2	3 1/2
Greenwich Lino. (1/2)	1 1/2	1 1/2
Harrison and Crossfield. Pref. ..	162	171
Imperial Continental. (S)	84	84
Ditto. 3 1/2% Debenture (S) ..	10	10 1/2
India Rubber Co. (10)	3/6	4/6
International Salt	1 1/2	1 1/2
Ditto. Pref. (5/6 pd.)	11 1/2	11 1/2
Lever Brothers. 1st Pref. (10) ..	1 1/2	1 1/2
Lister & Co. Ord.	1 1/2	1 1/2
Mappin & Webb. Ord.	9 1/2	10
Neuchâtel Asphalt.	10 1/2	10 1/2
Nobel Dynamite. (10)	17 1/2	17 1/2
Ditto. Bearer (10)	10 1/2	11 1/2
Ditto. 5% Pref. (10)	1 1/2	1 1/2
Pears, A. and F. Ord.	12 1/2	12 1/2
Ditto. 6% Pref. (10)	36 1/2	38 1/2
Price's Candle. (16)	8 1/2	8 1/2
Rosario (5)	1 1/2	1 1/2
Salt Union. (4)	109	109
South Metropolitan 4% Standard (S)	73	75
Ditto. 3% Debenture (S)	1 1/2	1 1/2
United Alkali. (10)	6 1/2	6 1/2
Ditto. Pref. (10)	1 1/2	1 1/2
Val de Travers	1 1/2	1 1/2



THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY W. P. DREAPER, F.I.C.

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

VOL. III. No. 7.

JULY, 1914.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
,, ,, Abroad 8s. ,,

Metallurgy and Research.

In his presidential address to the Faraday Society, Sir Robert Hadfield dealt at length with the remarkable advance in the metallurgy of iron and steel since the study of this subject has received scientific treatment.

How necessary such research may be is instanced in the statement that Germany will in the near future exhaust her own supply of iron ore.

It was pointed out that for a hundred years or more French metallurgy, as regards the production of high-class steel, was "entirely misdirected by the idea to which the French metallurgists obstinately clung, that it was possible to produce in France bar iron of the same quality as produced in Sweden." To this want of judgment, due, by the way, to the researches of so celebrated an investigator as Réaumur, the English manufacturers (by using the Swedish raw material) gained a great advantage.

This presents an example of the difficulties which may sometimes result in a too rigid following of the results obtained in the laboratory.

"Works after works in France came to grief owing to the obstinacy with which the French clung to their methods of trying to utilise their own empire's products at the expense of quality." Thus by the accident of "British common sense and our practical way of looking regarding matters," we were, in the words of this authority, kept on the right road, and, as a result, "Sheffield became the centre of the special steel trade of the world, a position which it still holds."

Modern progress has been mainly due to the valuable properties of many of the alloys of iron discovered by means of systematic study. An example is seen in the so-called "high-speed steel," which contains no less than five different elements apart from iron.

Although research of this nature may not, on the face of it, seem so important or attractive as the discovery of a new metal, yet it may bring results of an equally important nature, and involves research conditions of an equally arduous nature. We do not remember the case for industrial research being put so convincingly. Again, in referring to the quotation that "a higher degree of reputation is due

to the discoverer than to the teacher of speculative doctrines, nay even of conquerors themselves," he also emphasises the value of the investigator. It is interesting to note that in quoting these words he refers to the address given by the Lord Bishop of Rochester to King Charles II. on the foundation of the Royal Society.

It is difficult to believe at the time Sir Robert Hadfield started his research work on the alloys (in 1882) that, in the light of our present knowledge, the investigation practically broke untrodden ground. Such facts as these serve to mark our extraordinary progress in industry when this is based upon science procedure, and the absolute triumph of the experimental method was surely never better illustrated than in this case.

THE FIFTY-FIRST ANNUAL MEETING OF THE INSTITUTION OF GAS-ENGINEERS AT LIVERPOOL.

NOTES ON THE PRESIDENTIAL ADDRESS, AND SELECTED PAPERS, BY OUR SPECIAL CORRESPONDENT.

THE Gas Engineers held a very successful annual meeting at Liverpool from June 16th to 18th, and the Presidential Address delivered by Mr. Edward Allen, the Chief Engineer of the Liverpool United Gas Light Co., before the members of the Institute on June 16th, was notable for two things: its conciseness and brevity. In the brief space of half an hour Mr. Allen dealt with the history of the Liverpool gas undertaking; described some of the special features of the Linacre gasworks; reviewed the technical progress during the past year of the methods of gas manufacture generally; discussed the human element in gasworks; and, finally, described the methods adopted at Liverpool for smoothing the relationship between the company and its employees. Those who did not hear the address would say it was impossible to deal, even inadequately, with such a list of subjects, in an address covering barely eleven pages, and requiring only 30 minutes for its delivery. Mr. Allen not only achieved this feat, but achieved it in such a manner that one felt there was little more to be said on each subject after he had finished with it. The writer of these lines has heard many presidential addresses in his time, but he never heard an address that contained, within the same compass, more information, and it would be well if Mr. Allen's example were to set a new

fashion in the matter of what is too often a tedious reiteration of well-worn facts.

The most interesting papers presented at the meeting, from the point of view of the chemical engineer, were those contributed by Dr. Carpenter on the "Purification of Gas by Heat," and by Mr. Abady on "Calorific Power as a Standard." Dr. Carpenter's paper took the form of a lecture, which was delivered before a very large audience on Wednesday morning, June 17th. This lecture showed that the South Metropolitan Gas Co. is once again prepared to give a lead to the gasworks of the country, this time in the matter of gas purification, for two of the works of this large company are now equipped with the necessary apparatus and plant for operating a new process of reducing the sulphur in gas. This sulphur, it may be explained, is present in two forms: either in combination with hydrogen as sulphuretted hydrogen gas, which can be removed easily by passing the gas over oxide of iron, or in combination with carbon, as carbon disulphide, which is much more difficult to break down or remove. It is to the description of a successful process for the removal of the latter that Dr. Carpenter devoted the main portion of his lecture. Based on suggestions made by Vernon Harcourt in the early seventies, the new process consists in raising the gas to a temperature of $450^{\circ}\text{C}.$, in the presence of finely divided nickel. The catalytic action of this metal, at the temperature named, causes the hydrogen contained in the gas to enter into chemical reaction with the carbon disulphide, sulphuretted hydrogen gas and free carbon being produced. In the more easily removable form of sulphuretted hydrogen, the sulphur can be removed as before, by passing over iron oxide, and thus Dr. Carpenter's process would not add greatly to the complexity or costliness of the existing plants and process. Figures were given showing that nearly 3,000 millions of cubic feet of gas had been treated at a cost of only 299d. per 1,000 cub. ft. by the new purification process since January, 1913, and that the sulphur had been reduced 78%, that is, to under 8.22 grs. per 100 cub. ft. The detailed figures are given below:—

WORKING RESULTS OF THE NEW SULPHUR EXTRACTION PROCESS AT OLD KENT ROAD WORKS, JANUARY, 1913, TO MAY 31ST, 1914.

Total gas treated . . .	2,335,776,000 cub. ft.
Sulphur before treatment .	39.74 grs. per 100 cub. ft.
Sulphur after treatment .	8.22 " "
Percentage reduction . .	79.3%

EAST GREENWICH WORKS, APRIL 1ST TO MAY 31ST, 1914.

Total gas treated . . .	483,885,000 cub. ft.
Sulphur before treatment .	35.07 grs. per 100 cub. ft.
Sulphur after treatment .	7.82 " "
Percentage reduction . .	77.7%

The second paper which deserves the attention of chemical engineers was that by Mr. Jacques Abady on "Calorific Power as a Standard of Quality," read at the Thursday morning session of the meeting. The necessity for instituting some new standard of quality in the gas-making industry is due to the introduction of the incandescent mantle for lighting purposes, and to the gradual decline in numbers and importance of the consumers who use the old form of bats-wing or flat-flame burner. The photometric or candle-power standard of quality which was employed in the earlier days of the gas industry has, therefore, ceased to have much value, for the light emitted by an incandescent mantle depends not upon the candle-power of the gas burned, but upon its thermal or heating value.

To maintain the old standard of 16 or 20 candle-power of gas, long after the necessity for its maintenance has passed away is a wasteful policy, for high candle-power involves the use of cannel coal, or of enriching materials, and this, of course, means high production costs, and a high price for the gas sold. All the larger and more progressive gas companies and undertakings in the country are obtaining therefore the necessary parliamentary sanction for dropping the old candle-power standard of quality, and Mr. Abady's paper contained a summary of the more important details and regulations inserted in the new Bills, so far as these related to the standard of quality.

The Gas Light and Coke Co. was the first illuminating gas company to obtain an Act in which a calorific standard of quality was employed, this being in 1909, and the standard being 125 calories net, with a penalty when the calories fell below $112\frac{1}{2}$ net. The following are the details of the calorific standards inserted in Acts obtained since that year:—

Name of Company or Corporation.	Year.	Calorific Standard.	Penalty Point.
Wandsworth, Wimbledon, and Epsom.	1912	136 calories (gross).	122 calories (gross).
South Suburban . . .	1912	540 B.Th.U. (gross).	475 B.Th.U. (gross).
Porthcawl . . .	1913	540 B.Th.U. (gross).	475 B.Th.U. (gross).
Redcar, Coatham . . .	1913	125 calories (net).	112 calories (net).
Morley Corporation . .	1913	540 B.Th.U. (gross).	475 B.Th.U. (gross.)
Gas Light and Coke Co.	1914	540 B.Th.U. (gross).	500 B.Th.U. (gross).
Liverpool . . .	1914	550 B.Th.U. (gross).	523 B.Th.U. (gross).

Mr. Abady pointed out that the decision of the Parliamentary Committee in the last two Bills differed from the preceding ones, in the lessening of the margin between the standard and the penalty point, this margin being reduced to 40 B.Th.U. in the case of the Gas Light and Coke Co., and to 27.5 B.Th.U. in that of the Liverpool company.

In the last two Bills also it is stipulated that a photometric test of the gas shall be made daily for information only, but no standard of photometric value is named in the new regulations, and no penalties will be incurred if the candle-power falls to a very low value. One speaker, in the animated *discussion* which followed the reading of Mr. Abady's paper, in fact, urged that it would be better to supply a perfectly non-luminous gas, since then, all the consumers who still use the flat-flame burner would be forced to scrap their old gas fittings and burners. However, this view did not find much support. There can be no doubt, however, that the adoption of the calorific power standard will benefit the general public, for it will enable cheaper materials to be used in the manufacture of gas, it will enlarge the gas-makers field of supplies of raw materials and will reduce the cost per 1,000 cub. ft. considerably. This was the general opinion of the president himself, and of all who discussed Mr. Abady's paper, and the only points of difference that arose concerned the exact standard to be employed, the use of gross in place of net values, and the technical details of the methods of determining the calorific value.

Limits of space will not permit any notice of the other papers read at the meeting, or of the very valuable reports dealing with "Refractory Materials" and "Ventilation."

THE EDUCATION OF INDUSTRIAL CHEMISTS.

By DR. W. A. CASPARI, University College, London.

ALL due deference to isolated optimistic opinions need not blind us to the fact that chemistry, under present conditions, is a poor sort of career; and no argument from expediency or worldly wisdom will prevent any right-minded man from believing that it ought, on the contrary, to be one of the best. Not only are the prizes disproportionately few, but the dreary sequence of years which elapses before a chemist's income is such that he can decently marry is apt to be intolerably long. And, unfortunately, the state of affairs is steadily going from bad to worse. Although industries of a wholly or partially chemical character are continually growing in scope and magnitude, it becomes every year more difficult to find employment for the "young entry" of highly-trained chemists who have finished their course at universities or similar institutions. In other words, the supply of chemists is—slowly indeed, but indubitably—gaining on the demand.

Let us, following the sound practice of economists, analyse supply and demand separately, and let us take the latter first. The demand, such as it is, comes principally from our industries. Educational, professional, and Civil Service posts, independent consultancies, etc., can take up only a limited portion of the present output of graduate chemists, something like 15 or, perhaps, 20 per cent. Much wider, even under present conditions, is the demand from industry, and so we find that from two-thirds to three-quarters of the output go into industrial employment.

Now the latter demand, unlike the former, is capable of very considerable expansion. Over and over again our manufacturers have been taxed with employing too few chemists, and, if British be compared with foreign statistics, the charge would appear to be well founded. To stimulate the demand by preaching at British manufacturers does not, however, seem a very hopeful proceeding. The manufacturers must be supposed to know what they are about, and in any case they are masters of the situation. Some of them deny the usefulness of chemists outright, others are beginning to make use of them tentatively, others again—and this is significant—are employing more and more factory-bred men who have learnt what little chemistry can be learnt in their or other works, but are fighting shy of, or actually discarding, properly trained chemists of university standard. It is this latter tendency which is particularly worthy of attention, because it indicates that there may be something wrong with the quality of the supply.

What, in fact, many employers find is that university-trained men do not fit smoothly enough into the industrial machine. In these days of big firms and acute competition, factory organisation has been driven to a high pitch; and a jarring cog-

wheel, however great its potentialities for good, will not only tend to dislocate the machine but will, by the mere fact of jarring, render its own virtues ineffectual. By what kind of cog-wheel applied science should be represented it is the manufacturer's own business to decide; if he does so shortsightedly, so much the worse for himself. In order, then, that a chemist may be a success in a factory, he must possess certain qualities lying quite outside the sphere of his scientific proficiency. He must, for instance, genuinely understand and respect the aims of manufacturing industry, fully realising how different they are from those of pure science. He must have an inborn or acquired faculty of getting on with all sorts and conditions of men, however different their origins and education from his. He must be as amenable to discipline as a Prussian soldier, and he must school himself to feel at home in a factory *milieu*, no matter how unlovely and ruffianly it may be. Of these qualities some will depend almost wholly, others at least partially, on his training.

Turning now to consider the supply side, *i.e.*, the kind of chemists offered to industry by the universities, we may ask ourselves how far the training they receive inculcates the qualities referred to above, bearing in mind that careers other than industrial employment are open to but a minority of graduates. The reply can only be, very little. A university laboratory mostly tends to put professional and Royal Society ideals before the students and to teach them that the whole duty of man is the intensive production of researches acceptable by the scientific Press. This, of course, is quite in order for the few who will find billets in academical life, but is it right to force the ideals and habits of thought of the few on the many? One would hardly think so, yet that is what is done. It is done, more or less unconsciously, because the teachers have an inside knowledge of academical, but not of industrial life. Professors of chemistry who have served even a day as factory employees are great rarities.

Professors of engineering prepare mainly for the engineering industry and are expected to have served their time in a works. Professors of medicine and surgery prepare for the medical profession, and are expected to be, or to have been, in private practice. But it counts greatly against a man's chances of a chair of chemistry to have been a works chemist.

The consequences that flow from this anomaly are too manifold—and, indeed, too obvious—to be worth labouring in detail. The upshot, broadly speaking, is that chemists destined for industrial employment are being trained by men who are very able and very enlightened, but who, with respect to industrially applied chemistry, are amateurs.

At best these men, whilst doing something to quicken the technological sense in students, cannot, or will not, go far enough; to be sure, this would involve fighting very hard against that strange academic spirit, so-called, which resents anything "utilitarian," even in this twentieth century. At their worst they engender in their disciples a positive contempt for applied science.

It seems most desirable, in view of the growing dislike on the part of manufacturers for university-bred chemists, that the universities should set their houses in order and make a serious attempt to serve up the right kind of men. If they do not, it is difficult to see why the manufacturers should not presently set up a scientific training college or colleges of their own and so cut out the universities. Once there is agreement among manufac-

turers as to what exactly they want, the universities will have the pistol at their heads: they will either have to toe the line or limit their educational activity to something very like "taking in one another's washing," the needs of industry being then met by institutions in which chemistry is taught, and young men are trained, with an eye to realities.

So far, the manufacturers are anything but unanimous, and those that do know what they want are not over-candid about it; hence there is some excuse for the universities in not exerting themselves to play up to them. But if the universities, taking higher ground and mindful of their duty to the national industries, were to enter upon a forward policy of their own initiative, it would be to everybody's advantage.

THE HEXITE-PENTITE THEORY AND ITS BEARING ON THE CONSTITUTION OF KAOLIN.

By BERTRAM CAMPBELL, B.Sc., A.I.C., Inorganic Research Department, Imperial College of Science and Technology, South Kensington, S.W.

IN the year 1903 the Faculty of Philosophy in the University of Göttingen proposed the following thesis in connection with the Benek Bequest. *A critical examination, based on experimental evidence, is to be made of such chemical compounds as cannot be satisfactorily explained by the usual means. This examination should also take into special consideration the extent to which the introduction of molecular additions is of importance in the formation of such compounds, and whether it is possible to devise a complete systematic arrangement of such compounds.*

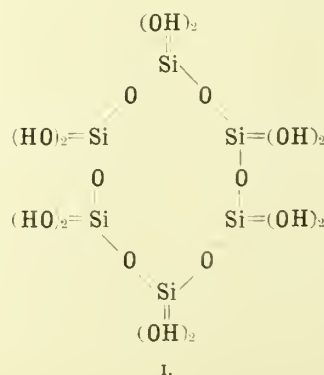
Drs. W. and D. Asch¹ devised a theory for one highly important group of complex compounds—the silicates. The Hexite-pentite theory was applied to a series of silicates of technical and commercial value, such as the ultramarines, Portland slag, dental and other siliceous cements, glass, glazes, porcelain, etc., in order to elucidate their constitution.

The theory commences with the assumption that Nature has formed all substances in accordance with Monistic laws, and has been applied to the study of the structure of other complexes as well as to that of solutions of the simpler acids, etc. It has also been employed in connection with the constitution of organic compounds, to form a bridge between organic and inorganic chemistry. The H.P. theory—as distinct from older ones—is concerned especially with inorganic chemistry and has the following characteristics. It is a general and unitary theory; it is based on a single truth, *i.e.*, on a natural law found by inductive reasoning; it leads *par excellence* to prognosis and therefore permits of deductive reasoning—the combination being a clear sign of a true theory. Moreover, it comprehends the best of the existing theories or explains their deficiencies.

A critical examination of the aluminosilicates and such complex compounds as the silicotungstates, the phosphotungstates, etc., shows that these are closely related substances, and shows moreover that in all probability these groups of compounds may be regarded as members of a single class. The previous theories of the constitution of the aluminosilicates cannot be regarded as satisfactory as notable objections can be raised against each, and none of them is capable of logical application to the interpretation of the chemical nature of the aluminosilicates as a whole, nor can any of them be used for a systematic classification. At the same time, it should be noted that the conception of the aluminosilicates as complex acids or salts agrees well with the facts.

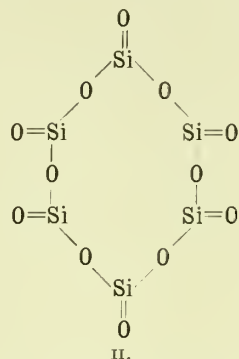
A hypothesis has been proposed by W. and D. Asch (*loc. cit.*) to show the bonding of the atoms in the aluminosilicates and related compounds.

Hexite.—If six molecules of $\text{Si}(\text{OH})_4$ unite together, splitting off water and retaining the quadri-valency of silicon, so as to form a "closed ring" the following constitutional formula is produced:—

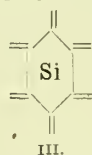


¹ "The Silicates in Chemistry and Commerce" (translation from German by A. B. Searle), Constable, London, 1913.

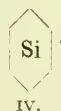
If six molecules of water are split off from I. the constitution shown in formula II. is produced :—



Formula I. is shown in abbreviated form by means of the following symbol :—

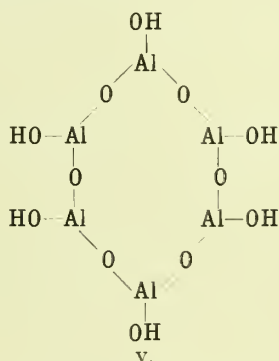


and formula II. by the symbol :—

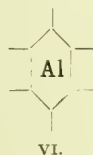


In what follows these abbreviated forms will be used in place of formulæ I. and II.

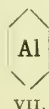
If six molecules of $\text{Al}(\text{OH})_3$ unite together to form a "ring," after losing six molecules of water but retaining the trivalency of the aluminium, formula V. is obtained :



By removal of three molecules of water from formula V. the anhydride $3\text{Al}_2\text{O}_3$ is produced. Instead of formula V. the symbol

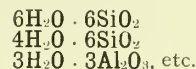


may be used, the complex $3\text{Al}_2\text{O}_3$ being then represented by



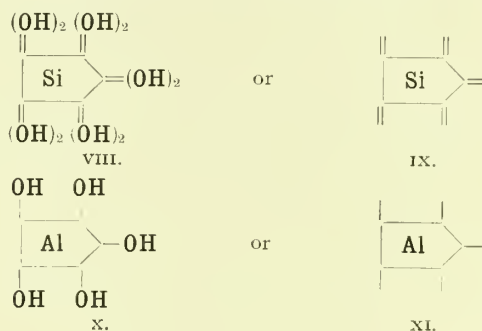
The radicals indicated by the symbols in formulæ IV. and VII. are termed "Hexite," 6SiO_2 being known as "silicon hexite" and $3\text{Al}_2\text{O}_3$ as "aluminium hexite." For Si hexite and Al hexite the respective symbols $\hat{\text{Si}}$ and $\hat{\text{Al}}$ will also be employed.

The hydrates of these hexites—such as

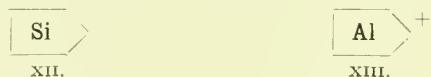


are termed "hydrohexites."

Pentite.—If five molecules of $\text{Si}(\text{OH})_4$ or $\text{Al}(\text{OH})_3$ form rings in a manner similar to hexite the following structural formulæ are produced :—



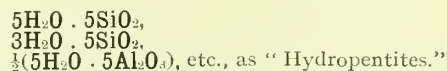
If the appropriate number of molecules of water is removed the anhydrides



are obtained

The meaning of the symbols and formulæ is clear from the statement made with regard to hexite ; in addition the sign + in formula XIII. indicates that an even number of these radicals must be present as such an expression as $\frac{1}{2}(5\text{Al}_2\text{O}_3)$ is impossible with existing conceptions of molecules.

The ring forming polymerisation products represented by formulæ XII. and XIII. are termed "Pentite," that corresponding to $\text{Si}(\text{OH})_4$ being referred to as "silicon pentite" that corresponding to $\text{Al}(\text{OH})_3$ as "aluminium pentite" and the hydrates :



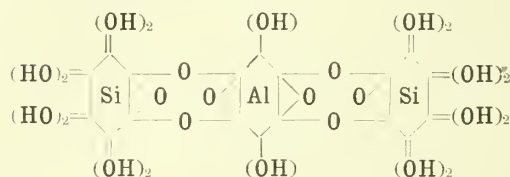
The pentites of silicon and aluminium will be indicated by the symbols $\bar{\text{Si}}$ and $\bar{\text{Al}}$ respectively.

By means of the silicon and aluminium hexites and pentites the chemical structure of the complex aluminosilicic acids and their anhydrides can be represented. The mode of formation of the acids appears to be according to the following rules :—

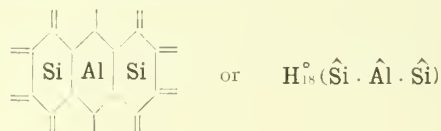
(a) The hydrohexites and hydropentites of aluminium unite with those of silicon or *vice versa*, the two neighbouring hydroxyl groups in the *ortho*-position in these rings splitting off the elements of water, two other OH groups also in the *ortho*-position in the silicon ring, losing their H atom and forming free H_2O .

By this means

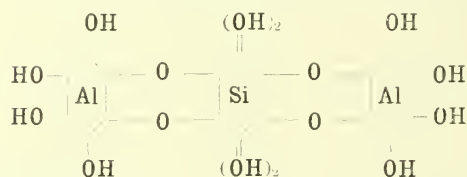
- i. From one aluminium hydrohexite and two silicon hydrohexites, viz., from $3\text{H}_2\text{O} \cdot 3\text{Al}_2\text{O}_3$ and $6\text{H}_2\text{O} \cdot 6\text{SiO}_2$ is obtained the formula :



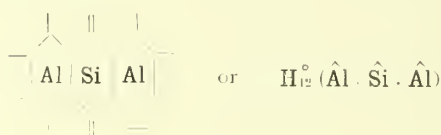
This may be expressed in the abbreviated forms



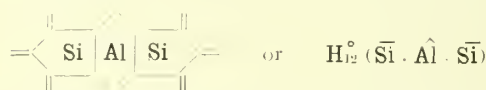
- ii. From a silicon hydrohexite ($4\text{H}_2\text{O} \cdot 6\text{SiO}_2$) and two aluminium hydrohexites ($3\text{H}_2\text{O} \cdot 3\text{Al}_2\text{O}_3$) is obtained the formula :



or the symbols :



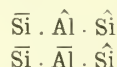
- iii. From one aluminium hydrohexite ($3\text{H}_2\text{O} \cdot 3\text{Al}_2\text{O}_3$) and two silicon hydro-pentites ($5\text{H}_2\text{O} \cdot 5\text{SiO}_2$) are obtained the symbols :



which need no further explanation. From (a) it follows that each Al hydrohexite can combine with two or at most three Si hydrohexites or hydro-pentites, water being split off. The reverse is naturally the case with the Si hydrohexites; the hydro-pentites, on the contrary, can obviously combine with, at most, two hydrohexites.

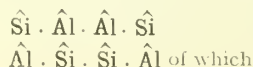
(b) Only those types are produced, from the radicals just mentioned, in which the "rings" or nuclei are distributed quite symmetrically. From this it follows:—

- i. That such types as :

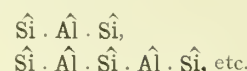


are completely excluded as they are unsymmetrical.

- ii. The type $\hat{\text{Si}} \cdot \hat{\text{Al}}$ must be doubled. It then yields two isomeric types :

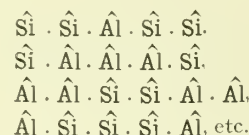


- iii. Both ends must be formed of absolutely similar radicals, as :

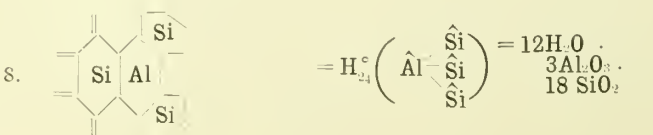
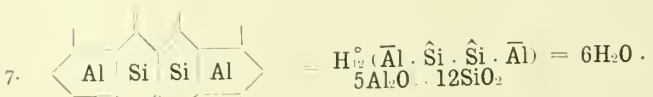
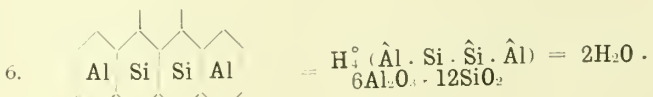
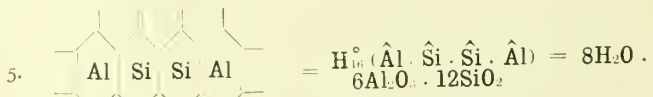
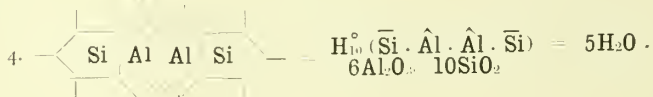
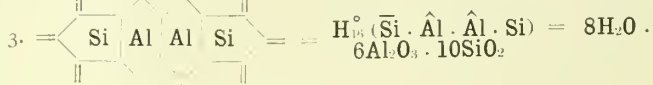
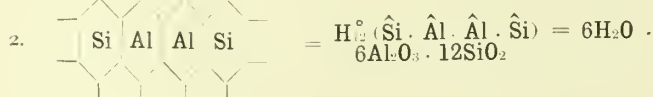
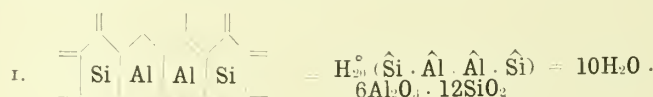


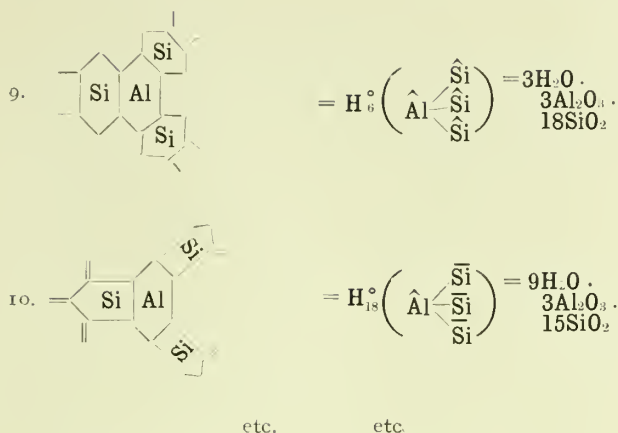
It also follows that from the type $\hat{\text{Si}} \cdot \hat{\text{Al}} \cdot \hat{\text{Si}}$ no such isomer as : $\hat{\text{Si}} \cdot \hat{\text{Si}} \cdot \hat{\text{Al}}$ is possible.

(c) The types can only have a group of two similar radicals of the same elements in the middle and not at the ends. Even in the middle they cannot have more than two similar radicals of the same substance. The following types are therefore excluded



From what has been already stated it will be seen that the following structural formulæ are possible :





and that these atoms must produce different chemical and physico-chemical properties according to their position in the whole molecule. An example will make this clear. In the following type:—



1. $\frac{1}{3}$ of the Al.
2. $\frac{1}{3}$ of the Si.
3. $\frac{1}{3}$ of the base or OH groups, or the substitutes F, Cl, etc., must clearly behave differently from the other $\frac{2}{3}$.

P. Silber² has shown that the behaviour of the compound $6Na_2O \cdot 6Al_2O_3 \cdot 12SiO_2$ (nepheline) = $Na_{12}^{\circ} (\hat{Si} \cdot \hat{Al} \cdot \hat{Al} \cdot \hat{Si})$ of the same type towards gaseous HCl and Ag solutions indicates that $\frac{1}{3}$ of the Na behaves differently from the remainder and thus confirms the H.P. theory.

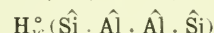
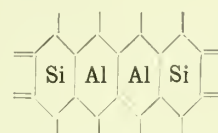
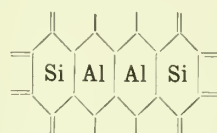
The H.P. theory shows the possible existence of a large number of aluminosilicic acids in the form of hydrates and anhydrides. Thus, if $\hat{Si} \cdot \hat{Al} \cdot \hat{Al} \cdot \hat{Si}$ is taken as the type, the following are a few of the possible hydrates:—

- (a) $6Na_2O \cdot 6Al_2O_3 \cdot 12SiO_2 = Na_{12}^{\circ} (\hat{Si} \cdot \hat{Al} \cdot \hat{Al} \cdot \hat{Si})$
- (b) $3Na_2O \cdot 3Al_2O_3 \cdot 12SiO_2 = Na_6^{\circ} (\hat{Si} \cdot \hat{Al} \cdot \hat{Si})$
- (c) $3Na_2O \cdot 3Al_2O_3 \cdot 10SiO_2 = Na_6^{\circ} (\hat{Si} \cdot \hat{Al} \cdot \hat{Si})$

only those atoms which are outside the brackets (*i.e.*, Na atoms) can be replaced by K, Mg, Ca, etc. No such replacement can occur with the Al atoms and the alumina-silica ratio must remain unchanged. As a matter of fact, no replacement of the Al by elements which form oxides of the R_2O or RO type has yet been observed either in the so-called pseudo-morphous processes or during the course of experimental researches in the laboratory.

Lemberg¹ by treating an artificially prepared compound $Na^{\circ}K_6^{\circ} (\hat{Si} \cdot \hat{Al} \cdot \hat{Si} \cdot \hat{Al} \cdot \hat{Si})$ with varying amounts of salt mixtures (NaCl, KCl, $MgCl_2$, etc.) obtained thirteen compounds all having the general formula $R_n^{\circ} (\hat{Si} \cdot \hat{Al} \cdot \hat{Si} \cdot \hat{Al} \cdot \hat{Si})$. From all these thirteen compounds he could only obtain a replacement of the atoms outside the bracket $Na^{\circ}K_6^{\circ} (\hat{Si} \cdot \hat{Al} \cdot \hat{Si} \cdot \hat{Al} \cdot \hat{Si})$ and the alumina-silica ratio remained constant. A large number of analogous phenomena all lead to the same conclusion.

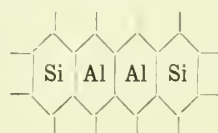
The structural formulæ devised by W. and D. Asch show that the aluminium and silicon atoms in an aluminosilicate do not always behave the same in chemical and physico-chemical investigations. Under certain circumstances some of these atoms behave differently from the rest, and the same is true of the monovalent and divalent elements in their compounds. It not infrequently happens that the OH-groups which form the "water of constitution" in the aluminosilicates are replaced by the halogens, F and Cl. The structural formulæ show that, in the latter case, halogen atoms may be united in various ways in a single aluminosilicate



If all the contained water is completely separated the anhydride $\hat{Si} \cdot \hat{Al} \cdot \hat{Al} \cdot \hat{Si}$ is formed.

The above hydro-aluminosilicates may also contain a variable proportion of "water of crystallisation," the number of hydrates being thereby increased.

These substances have seldom, if ever, been prepared synthetically, though their occurrence in Nature is well known under the name "kaolins." They have been formed out of the most diverse materials, such as micas, feldspars, chlorites, etc., by removal of the base, hydration, and subsequent removal of water under definite conditions. From the formula $6H_2O \cdot 6Al_2O_3 \cdot 12SiO_2$ (kaolin) two isomeric substances may be formed.



A

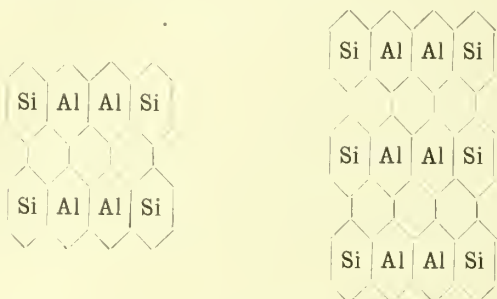


S

¹ Zeitschr. d. Deutsch. geol. Gesellsch., 1876, 574—5.

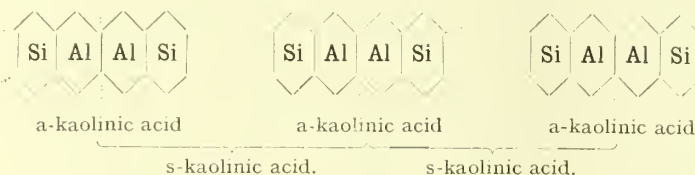
² Ber. d. Deutsch. chem. Ges., 1881, 14, 941.

The acid with central Al rings may be shortly termed a-kaolinic acid, and that with the central Si rings s-kaolinic acid. Two, three, or more molecules of the acid A and of the S may lose certain molecules of water and then unite to form polymerisation products. Thus the following compounds are possible :

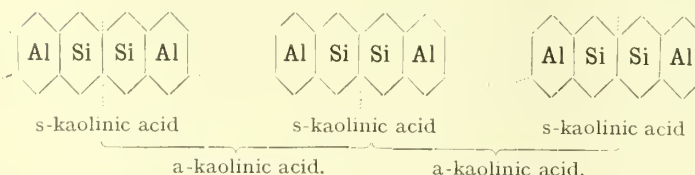


Between the a- and s-kaolinic acids and their salts there must be a genetic relationship as they can be converted into each other.

I. Conversion of a-kaolinic acid into s-kaolinic acid.



II. Conversion of s-kaolinic acid into a-kaolinic acid.

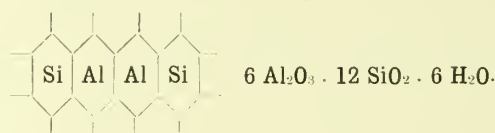


In an analogous manner the polymerised a-kaolinic acids may be converted into s-kaolinic acids and *vice versa*.

There are two kinds of OH groups in the kaolinic acids, termed a- and s-hydroxyl groups. The former—the hydroxyls of the Al rings—are acidophillic, and the latter—the hydroxyls of the Si rings—are basophillic. The a-kaolinic acids—both simple and polymerised—appear to contain more Si hydroxyls and less Al hydroxyls; the s-kaolinic acids, on the contrary (both simple and polymerised) contain more Al hydroxyls and less Si hydroxyls. These variations in the number of Al and Si hydroxyls of the a- and s-kaolinic acids must result in these acids having a different relationship to other acids and a different solubility in acids. The more Al hydroxyls a-kaolinic acid contains, the more soluble must it be in acids or, in other words, the s-kaolinic acids must usually be more soluble than the analo-

gous isomers or a-kaolinic acids. As the degree of polymerisation must diminish with Al hydroxyls, it follows that *caeteris paribus*, the polymerised kaolinic acids, must be less soluble in acids than the non-polymerised ones. From the theory it follows that the anhydrides of the a-kaolinic acids have the lowest degree of solubility in acids and therefore the greatest resistance to acids. The a- and s-kaolinic acids must also differ from each other in physical characters, such as density, resistance to reagents, etc., as well as in chemical structure.

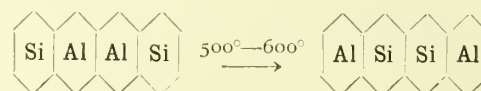
Mellor and Holdcroft¹ have made a study of kaolin by means of the purest china clay possible, this kaolin having a composition approximating very closely indeed with the formula $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$. The result of their investigation leads the authors of the H.P. theory to the conclusion that in all probability china clay is an a-kaolinic acid with a structure represented by



The heating curve plotted by Mellor and Holdcroft for pure kaolin shows, at temperatures above 500°C ., a reduction in the rate at which the temperature rises, and this is doubtless due to the occurrence of an endothermic or heat-absorbing reaction. At 900°C . a feeble exothermic reaction occurs, and between $1,000^\circ\text{C}$. and $1,200^\circ\text{C}$. another strong endothermic reaction takes place.

The H.P. theory enables these critical temperatures to be explained.

The a-kaolinic acid is converted on heating to $500^\circ\text{--}600^\circ\text{C}$. into a derivative of s-kaolinic acid, thus—



At a higher temperature, 900°C ., the s-kaolinic acid is polymerised with a liberation of heat, and at a temperature of $1,000^\circ\text{--}1,200^\circ\text{C}$. the polymeric anhydride of the s-acid is converted into a polymeric anhydride of the a-kaolinic acid with absorption of heat.

If this conversion of the a-kaolinic acid into an anhydride of s-kaolinic acid really does take place at a temperature of $500^\circ\text{--}600^\circ\text{C}$., it follows that the product formed by heating kaolin to this temperature must be more readily soluble than the original kaolin. This interesting consequence of the H.P. theory has been independently and experimentally confirmed by Mellor and Holdcroft,

¹ Trans. Eng. Cer. Soc., 1910 10, 94—105.

who found that the dehydrated kaolin is more active than the kaolin from which it was prepared and its solubility in acetic, hydrochloric and nitric acids is greater than that of the unburned kaolin. It is probable that the anhydride of the s-kaolinic acid formed at 600° C. becomes partially hydrated when under the influence of these acids, and the acidophilic OH groups (the a-OH groups) thus formed—being twice as numerous as the OH groups in the a-kaolinic acid molecule—will make the product more closely related to acids and will simultaneously increase its solubility in acids.

The specific gravity of the s-kaolinic acid must clearly differ from that of the a-kaolinic acid, and the investigations of Mellor and Holdcroft have

shown that this is the case, the specific gravity diminishing as the conversion of the a- into the s-kaolinic acid takes place. The table below shows that at 600° C. the specific gravity of the kaolin is distinctly lower than at 110° C. At higher temperatures the polymerisation which occurs and the formation of the polymerised anhydride of a-kaolinic acid must necessarily result in a series of increases in the specific gravity of the material.

Temperature.	Specific Gravity
110°	2'615
600°	2'473
700°	2'469
800°	2'497
900°	2'560
1,000°	2'734

CHEMICAL INDUSTRIES.

A Monthly Review of the Progress of Technical Chemistry.

OILS, FATS AND MILK PRODUCTS.

By CECIL REVIS and E. RICHARDS BOLTON.

A WORK which will be of the greatest interest to those connected with the examination of oil-seeds, etc., has been published by the Imperial Institute, entitled "Oil-seeds, Oils, Fats and Waxes," being selected reports from the Scientific and Technical Department of the Institute. It contains most interesting matter and may be obtained from Messrs. Wyman and Sons, Ltd. (8½d.).

Hydrogenised fats must, as usual, again take a prominent place in this review. It has always been a matter of question as to whether the introduction of hydrogen under the action of a catalyst proceeds along the simple lines demanded by theory, or whether secondary reactions occur resulting in the production of more complex glycerides. In this connection may be noted the work of Leimdörfer (abs., *Chem. Zentr.*, 1914, I, 314), who is of the opinion that the stearin of hydrogenised fats differs in several physical properties from the stearin found in untreated fats, and is of the nature of an allotropic modification, and, further, that it is also characterised by a higher reaction velocity during saponification. Meigen and Bartels (*Journ. prakt., Chem.* 1914, 89, 290) have ascertained that hydrogenisation proceeds at a lower temperature when finely divided nickel is used than is the case with nickel oxide. On the strength of this they differ from Bedford and Erdmann, who attribute the reaction to the formation of an oxide.

The melting points and refractometer figures for a number of hardened fats have been published by Ellis (*Journ. Ind. Eng. Chem.*, 1914, 6, 117). This author states that the products obtained from arachis and sesame oils were analytically indistinguishable from lard fat, while the product from whale oil closely resembled mutton and beef fat. It is scarcely necessary to say that this similarity does not cover the examination of the sterols present.

A phenomenon which must have been noticed by many observers who have examined these fats for presence of nickel, is the fugitive pink colouration which is sometimes obtained in the complete absence of that metal; this has

been explained by Kerr (*ibid.*, 207) as being due to the presence of an organic base, as the acid extract, after evaporation and oxidation with nitric acid, no longer produces a colour unless nickel be actually present.

In passing, an article in *Les Matières Grasses* (1914, 7, 4027), by Bouchard, contains a number of analyses of the deposits obtained during the refinement of arachis oil as technically carried out in France. These pastes have a very high free fatty acidity, though the character of the fat does not differ markedly from normal arachis oil. They appear to have an outlet in soap manufacture. The unsaturated fatty acids of Japanese sardine oil have been examined by Majima and Oxada (abs., *Journ. Soc. Chem. Ind.*, 1914, 33, 362), and from their work it appears that some of the acids present are of a highly unsaturated character. The saturated fatty acids obtained by hydrogenisation resulted in the production of acids of a higher molecular weight than stearic acid.

Some most useful results have been obtained by Canzoneri and Bianchini (*ibid.*, 323) as a result of an investigation into the progress of rancidity in olive oil. It appears that air and sunlight are both necessary for the change, and that it is not the result of the action of micro-organisms, and these authors are of the opinion that the action is due, at least in part, to peroxide formation, which may account for the progressive character of the change.

The solubility of certain metallic salts of volatile fatty acids, notably the copper and iron compounds, according to Agullhon (*Bul. Soc. Chem.*, 1913, 13, 404), increases considerably with the molecular weight in the presence of organic solvents, and he has founded on this, methods of determining the admixture of higher volatile fatty acids with butyric acid in a simple qualitative manner. Similar tests apply in the case of propionic and acetic acids.

The decomposition of fatty acids of very varying character by the commonly occurring moulds has been examined by Spieckermann (*Zeit. Unters. Nahr. Genussm.*, 1914, 27, 83). Lauric acid is completely oxidised, and myristic acid over 90%, while the higher fatty acids are not so open to attack. It is noteworthy that the fatty

acids recovered after the experiment were considerably altered from their original composition.

Before passing from the subject of fatty acids, it may be noted that Fodor (*ibid.*, 26, 641) is of the opinion that the caproic acid in butter fat is the normal acid and not isobutyric acid.

Among analytical methods may be noticed a continuation of Bömer's work (*ibid.*, 27, 153) on the detection of beef and lard fats by the difference in the melting points of their fatty acids. This latest work includes the detection of beef fat in lards containing vegetable oils and of lard and beef fat in coconut oil and in butter.

The digitonin method of estimating unsaponifiable matter has been extended by Salomon (*Ber. deutsch. Pharm. Ges.*, 1914, 24, 189), who proposes to divide the unsaponifiable matter into liquid and solid constituents by means of digitonin, and has worked out the relative proportions for a number of oils and fats.

Though carbon bisulphide is not so much used as a solvent for the "extraction" of oils and fats, as it probably is on the Continent, yet a test devised by Utz (*abs.*, *Chem. Zent.*, 1914, 1, 578) for its determination in "extracted" oils may be useful, an alcoholic distillate of the oil being treated with thallo-acetylacetone, when a characteristic precipitate is formed even with 1% of the solvent.

Fahrion's modification of Twitchell's method for estimating rosin in oils, etc., has been criticised by Wolff and Scholze (*Chem. Zeit.*, 1914, 38, 369), who have worked out a procedure which, according to them, gives satisfactory results.

It may be noted (*ibid.*, 137) that a rapid method of determining the percentage of "hulls" in cotton seed meal is due to Grimme, the method depending on the quantity of ash-free residue obtained after the digestion of the fat-free meal with dilute hydrochloric acid.

In connection with milk products we may note a most ingenious method of determining the concentration of condensed milk, without withdrawing samples from the can, by means of an electrical conductivity method. This has been published by Jackson and others (*Journ. Soc. Chem. Ind.*, 1914, 33, 59), and the process appears so far only to have been used on a laboratory scale, so that the commercial application will be awaited with interest, as the practical difficulties which would occur ordinarily with such a viscous liquid are obviated by a simple control method.

Though not strictly within the scope of this article, the following may be of interest: (1) A paper on the viscosity of milk by Kooper (*Milch Zent.*, 1914, 43, 169). The determination is made in a special instrument, and, by means of a factor, the total solids are given with a considerable degree of accuracy, and determinations of added water are also possible by this method. (2) The detection of added water in milk may be made, according to Mathieu and Ferré (*Ann. Falsif.*, 1914, 7, 12), by the determination of the percentage of lactose and sodium chloride and the application of a simple formula.

A very thorough investigation into the possibilities—or, rather, impossibilities—of sterilising milk by ultra-violet rays is due to Ayres and Johnson (*Cent. fur. Bakt., Abt.*, 11., 1914, 40, 109), though an entirely new application of the rays has just been patented by Edwards (*Eng. Pat.* 8500, 1913), in which the milk is sprayed into a chamber containing quartz lamps, and which may possibly prove more effective.

The methods of estimation of fat in dried milks form the subject of a critical review of methods by Utz (*Milch*

Zent., 1914, 43, 113). His conclusions are that the Polenske method is the quickest and the best, and the paper also contains tables of a number of analyses of dried milk.

Two papers have appeared in connection with the ripening of cheese: (1) by Fodor (*Zeits. Unters. Nahr. Genussm.*, 1913, 26, 225) on the abnormal ripening of Liptauer cheese, is distinctly interesting, and some curious changes taking place are discussed, particularly in connection with abnormal characters developed in the fat; and (2) on the bacteriology of the ripening of cheese of the Emmentaler type, by Eldredge and Rogers (*Cent. fur Bakt., Abt.*, 11., 1914, 40, 5). This latter investigation is of an elaborate type and similar in character to the work of Hastings and others on Cheddar cheese.

Apparatus for the Automatic Measuring and Injection of Chemicals.

—R. C. Parsons (London Section Society Chemical Industry) recently referred to the crude methods generally adopted for introducing chemicals into water, previous to its being filtered, and proceeded to describe his low-pressure injector, known by the name of the "Tiltometer," which is operated by means of the pressure obtained by inserting a venturi tube into the main in which the water to be treated flows. He then gave the results of the tests of this instrument, which proved to be an accurate and reliable apparatus for automatically treating water with a constant percentage of chemical, although the flow varies considerably.

The "high-pressure chemical injector," which also works by means of the pressure derived from a venturi tube inserted in a main was also explained. This apparatus can inject against any pressure, and consists of two cylinders in which pistons having wide circumferential grooves move quite freely, and by means of a controlling valve are made to eject the chemical alternately, thus maintaining a regular flow. Above the cylinders are the inlet and outlet valves, the former for admitting the chemical from a tank in which it is stored, and the latter through which it is injected into the main. On one side of this instrument is a manometer for indicating the venturi pressure due to the flow through the main, and, on the opposite, another manometer attached to a small venturi tube through which the chemical ejected passes, and the amount discharged measured. The ratio of these discharges gives the percentage of chemical added and can be adjusted by the regulating valve.

Both these instruments are shown to be simple, durable, reliable, and to yield very accurate results.

The Chemistry Department of the Technical High School at Dresden is being extended by additional buildings, which will contain separate laboratories for organic and inorganic chemistry, colour chemistry, electro-chemistry, and physical chemistry.

The academic sanatoria of the University of Kiel have established a radium laboratory. The Government endowed this institution with 250 mgs. of radium, and private individuals furnished it with 100 mgs. of mesothorium. The management has been entrusted to Dr. Hans Meyer.

Evans' Analytical Notes for 1914 issued under the direction of Mr. H. R. Jensen is devoted to the examination of raw materials and pharmaceutical products manufactured by Evans Sons, Lescher & Webb, Ltd., and contains interesting data of the results obtained during a period of one year in their laboratory.

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

CHAPTER VI.

UNTIL quite recently, the only methods of reduction available were those based upon the utilisation of "nascent" hydrogen liberated by the decomposition of water by sodium and of acids by metals, or, if cases of exceptional difficulty were encountered and risks could be incurred, the use of hydrogen iodide in sealed vessels was resorted to. But within the last decade or so the whole subject of reduction has been carefully studied from many aspects, with the result that several methods of great value have now been worked out in detail. These have already been employed in the laboratory for the preparation of a whole host of substances, hitherto unknown to chemists or very difficult to obtain by other means; whilst, in several instances, the laboratory process has been promoted to the industrial stage with conspicuous success.

In the domain of Organic Chemistry—and it is here that research upon reduction has been most actively engaged—the tendency has been towards the direct employment of hydrogen, *i.e.*, towards that main branch of reduction known as hydrogenation. In this way the complications introduced by the addition of extraneous material difficult of removal are avoided, and a clean, straightforward method, capable of great regulation and adaptation, results.

The direct union, however, of most unsaturated organic compounds with gaseous hydrogen is only effected by the aid of catalysts working under various conditions, *viz.* :—

- (1) Finely-divided metals at the ordinary temperature.
- (2) Finely-divided metals at moderate temperatures.
- (3) Metallic oxides at high temperatures and pressures.

A brief discussion of each of these methods in their general outline is desirable before turning to the most important of their industrial applications.

With the distinct method of electrolytic reduction it is not intended to deal in the present chapter, for, though its development has for some time attained the commercial stage, its interest from the point of view of catalysis is small. Reference will be made to it, however, in a later chapter.

CATALYTIC METHODS OF HYDROGENATION.

I. Use of Finely-divided Metals at Ordinary Temperatures.—Since the beginning of the nineteenth century it has been known that finely-divided platinum and palladium possess the property of occluding gases, particularly hydrogen, upon their surface. In the case of palladium, indeed, the effect

is so marked that until recent years it was thought that one or more compounds was produced by union with the hydrogen. In any case, instances are to be found in chemical literature in which this property has been taken advantage of for reduction purposes.

Within the last few years a revival of the method has taken place, initiated chiefly by Paal (1902), who has proposed to utilise the still further increased area which obtains in a colloid. Colloidal solutions of platinum, palladium, osmium and iridium—of which the palladium hydrosol appears to possess the greatest value—have been made by the action of some reducing agent, such as sodium protalbinat or lysalbinat, and later hydrazine, upon a solution of a salt of the respective metal. By merely passing at the ordinary temperature a current of hydrogen through a solution of, say, nitrobenzene, to which a little palladium hydrosol has been added, aniline can be obtained in large yield. The readiness with which hydrogenation takes place has suggested the application of the method to the estimation of hydrogen in gaseous mixtures in which the proportion of this constituent is not too small. Instead of the usual mixture with oxygen and subsequent explosion, the hydrogen is absorbed by a mixture of palladium hydrosol and some unsaturated compound, *e.g.*, sodium picrate, contained in a modified form of Hempel pipette.

A recent application of the method is to be found in the reduction of various oils, hard, brittle products being the result. The reduction of the glycerides of unsaturated fatty acids, and even of the acids themselves, has been brought about by this method—a result of no slight importance, as will be seen when the hydrogenation of oils is discussed. In these reactions, however, the palladium hydrosol is converted into the inactive gel form by the procedure necessary for the isolation of the products, and this has rendered the process a costly one on account of the high price of colloidal palladium. Now, the finely divided metal is precipitated upon inert substances devoid of anti-catalytic action, *e.g.*, powdered nickel, magnesium, chalk or kieselguhr, and the above difficulty is surmounted (Karl).

Skita, who has done much with Paal's method, finds that the hydrogen addition takes place more quickly and completely, as well as permits of extended application, if the pressure of the hydrogen be somewhat increased.

The use of platinum, not necessarily colloidal, but prepared by a special method in the finely-divided state, has been actively investigated by Willstätter, who demonstrates that many reductions, performed at higher temperatures in the case of the method next to be considered, can be easily accomplished by its aid at the ordinary temperature, though naturally at much slower rates than obtain

in the other method. Zelinsky uses specially prepared palladium in a similar way.

The utility of the method, then, lies in its application to the reduction of compounds which are not sufficiently volatile, or are too easily decomposable, to be subjected to either of the two following more rapid methods. Examples of the results obtained by this process cannot be given here, for, with few exceptions, most of the hydrogenations can be effected by the important method now to be considered.

II. *Use of Finely-divided Metals at Moderate Temperatures.*—Moissan first observed that acetylene, when brought into contact with recently-reduced nickel, cobalt or iron, as well as platinum black, was decomposed with incandescence, carbon being deposited, a gas believed to be hydrogen disengaged, and liquid hydrocarbons, particularly benzene, produced. His explanation lay in a simple physical condensation of the gas in the pores of the metal, which was considered conducive to combination. But Sabatier, who had been investigating the fixation of nitrogen peroxide by several oxide-reduced metals, and had observed the formation of true compounds, which he called metallic "nitroxyls," thought that Moissan's explanation was untrue to facts, and that, instead, some temporary unstable compound was the intermediate product. Sabatier took up this seemingly unimportant point, and tried the effect of bringing a mixture of hydrogen and acetylene into contact with reduced nickel. Complete transformation into ethane was the result (1899), and the foundation was laid for a hydrogenation method of tremendous significance.

The principle of the method is a simple one. The vapour of the substance to be reduced is mixed with hydrogen and passed directly over specific metallic catalysts maintained at temperatures usually situated between 150° and 200° C. Such a process differs from the others already mentioned in this chapter in its extreme rapidity, since complete hydrogenation occurs during the short time the mixture is passing over the catalyst. Rapidity, however, is not the only advantage, for Sabatier and his collaborators, Senderens, Mailhe and others, who have worked on this method for some fifteen years, find it to be one which, whilst requiring the minimum of attention, furnishes very high yields.

The metals which are suitable as catalysts are nickel, cobalt, platinum, iron and copper, of which nickel is far and away the most active, while the others are arranged in diminishing activity. As would be anticipated, the practicability of the method depends largely upon the condition in which the metal is used. It must be prepared by reduction of the oxide and preferably in the same vessel in which the subsequent reduction is to take place. The activity depends both upon the nature of the oxide employed and the temperature at which it is reduced. Obviously, the greater the surface exposed the greater the activity, so that the conditions must be carefully arranged to satisfy this requirement. Reduction at a low temperature is found to yield a

metal which is too active and too sensitive to external influences, while reduction at a high temperature almost reduces the catalytic power to zero. Consequently a suitable intermediate temperature must be chosen. Sabatier finds that the best nickel for the purpose is produced by dissolving the metal in nitric acid, calcining the nitrate at a dull red heat and then reducing the oxide slowly at a temperature of about 300° — 325° , until water is no longer evolved. After the nickel has been prepared as described, it is necessary to keep it out of contact with the air, as it is extremely pyrophoric and quickly loses its activity on exposure.

Weight for weight, the efficiency of pure nickel is not so great as that which has had its active surface increased by the aid of some suitable carrier. Hence many proposals have been made for combining the catalyst with a great variety of supporting bodies, ranging from pumice and kieselguhr to charcoal and sawdust.

There are two conditions for the conductance of the process, the rigorous observance of which is indispensable to success. In the first place, the materials used, whether hydrogen, metal or organic compound, must be as pure as can be obtained, for any impurity is readily absorbed by the catalyst to the detriment of its activity. Sulphur and its volatile compounds, as well as the halogens, are particularly to be avoided in this respect, and, to a lesser degree, arsenic and phosphorus with their volatile compounds. Electrolytic hydrogen, or hydrogen of equivalent purity, appears to be essential. Even then the catalyst must, sooner or later, succumb to the toxic effects of minute impurities impossible to remove, and, in consequence, the desirability of frequent renewal needs emphasis.

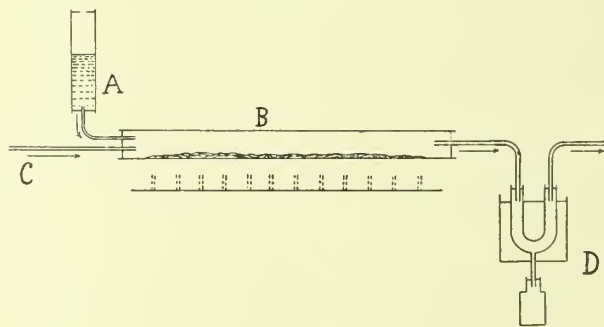


FIG. 11.

Again, it must be clearly recognised that a particular hydrogenation will only take place within predetermined limits of temperature, since any excursion outside of these limits will necessarily contaminate the final result with undesired subsidiary products and diminish the yield. The more difficult the reduction, the narrower is the range of temperature, and *vice versa*. The reduction of ethylene bonds, for instance, being easily effected, is possible within a comparatively wide temperature interval, whereas aromatic rings in general necessitate careful temperature adjustment.

In its elementary aspect the apparatus employed

is shown in Fig. 11. The industrial modifications, of course, vary with the nature of the process for which they are required, but the principle of the arrangement will be evident from a consideration of the laboratory apparatus shown. The tube, B, containing the reduced metal is heated in a furnace or oil-bath, or preferably by an electrical resistance apparatus, the latter being employed where uniformity of temperature is essential. Pure hydrogen is introduced at C, and sweeps in some of the organic compound, conveniently represented as being liquid and passing in from A. If the compound is solid it is melted in a distilling bulb and the hydrogen bubbled through. Contact with the reduced metal, usually nickel, effects the reduction and the products are condensed in D.

Having thus briefly outlined the method and the conditions necessary for its success, attention will now be directed to some of the very important results obtained by its aid. A cursory glance only can be attempted, for it must be remembered that, whereas only a few examples can be instanced, they are really legion.

Thus fatty and aromatic nitro-bodies are found to yield the corresponding amine. A practical application of this is to be found in the manufacture of aniline, for by this method, not yet fully appreciated by manufacturers, the reduction of nitrobenzene can be easily realised in a continuous way. Copper, however, is preferable to nickel as the catalyst, because it never brings about the further hydrogenation of the aniline produced. Moreover, as copper is not so sensitive as nickel to disturbing factors, water-gas or even purified coal-gas may be substituted for pure hydrogen. It might be mentioned in this connection that in the ordinary process for the manufacture of aniline by the reduction of nitrobenzene, using iron and hydrochloric or acetic acids, the iron functions in the manner of a catalyst, for only 5% of the acid theoretically necessary is really employed.

Again, ketones of both series are readily hydrogenated. Acetone, for instance, is converted into isopropyl alcohol with an efficiency which compares very favourably with that which results from the use of sodium amalgam and, in consequence, the cost has been greatly reduced.

An interesting case is that of the monoxide and dioxide of carbon. From the former, formaldehyde, and then the commercially important methyl alcohol might be expected, whereas in both cases only methane is produced. Nevertheless, this reaction has been utilised to great advantage in a process which aims at increasing the calorific value of water-gas by eliminating the carbon monoxide constituent by passage over reduced nickel at 350° — 400° C. In this way the residual coke of gasworks may be utilised for the manufacture of lighting gas.

The above reactions involve the substitution of hydrogen for oxygen in the compound. An equally important class of substances, however, fix their hydrogen by addition. This class naturally comprises most of the unsaturated compounds—double and triple link—of both the fatty and aromatic series.

In the case of simple fatty substances the addition of hydrogen is readily effected, the triple bond more so than the double, and copper is quite sufficient as the catalyst. More difficult, but of the greatest industrial utility, is the hydrogenation of unsaturated oils, which subject will be dealt with towards the end of the chapter.

The application of the method to compounds containing the aromatic nucleus is extremely wide, and includes, moreover, some of the most important reactions it is able to accomplish. Carefully reduced nickel is essential here, together with delicate regulation of the temperature. Under these circumstances such classes of compounds as the hydrocarbons, the phenols, the aromatic amines and acids can be hydrogenised to the corresponding compounds of the cyclohexane series. In fact, the method comprises the principal one known for the preparation of compounds of this type. Thus, to take some simple examples, benzene yields cyclohexane, phenol gives cyclohexanol, and aniline a mixture of cyclohexylamine, dicyclohexylamine and cyclohexylaniline. Naphthalene takes both 4 and 10, and anthracene 4, 8, 12 or 14 atoms of hydrogen, according to the temperature employed. This illustrates one of the important developments of the method, viz., the possibility it affords, by reason of the varying activity of the available metals and the temperature limits at one's disposal, of tracing a reaction step by step—a process which adds considerably to our knowledge of the constitution of the bodies under experiment.

By this means the process has been of the greatest service in the terpene and other series by the light it has thrown upon the constitution of these bodies; while it has similarly contributed to the elucidation of other problems of no little interest to the theory of chemistry.

Of practical importance is the preparation of numerous artificial perfumes by the aid of this reaction. Moreover, it permits of the production of cyclohexanol and *p*-methylcyclohexanol, easily obtained from phenol and *p*-cresol respectively, which are used in the manufacture of isoprene and butadiene, and seem, therefore, destined to play an important part in the synthesis of rubber—a problem which is at present occupying the attention of so many workers.

The mechanism of these remarkable catalytic reductions can be explained in several ways. It may be that the passage of the hydrogen over the finely-divided metal induces its decomposition into the atomic or "nascent" state, or that the temporary occlusion of the hydrogen upon the catalyst favours its interaction with the reducible body. A more probable explanation is that put forward by Sabatier himself, who supposes the formation of an intermediate unstable hydride upon the surface of the metallic catalyst, this hydride being capable of furnishing its hydrogen rapidly and in a suitable state to a substance which is able to utilise it. There might even be a series of hydrides formed, in which case the varying degree of activity of the different metallic catalysts would be explained,

since, then, the most powerful catalyst would be capable of forming the greatest number of hydrides. Seeing that it was this idea which led him to initiate his remarkable researches and has served as guide throughout, its utility provides a strong argument in its favour. When the subject of dehydrogenation is dealt with in the next chapter, it will be found to provide still further support to the above theory.

If only the existence of these compounds could be proved in some independent way, it would remove not a little of the uncertainty which rests upon the subject of catalysis in general.

III. *Use of Metallic Oxides at High Temperatures and Pressures.*—Nickel oxide heated to 200° in an atmosphere of hydrogen is reduced to metallic nickel, but if benzene be present it is found to be transformed into the hexahydro compound in the presence of this oxide at considerably higher temperatures without appreciable production of the metal. Observations of this nature, due to Ipatiew, led him to study the rôle of nickel and other oxides under the conditions of high temperatures and pressures in catalytic hydrogenation, with the result that we now associate with his name the method underlying his researches. Briefly stated, this method consists in bringing hydrogen at a pressure of at least 100 atmospheres into contact with the substance to be reduced in the presence of nickel or other suitable oxide heated to temperatures above 250°, and contained in a specially-constructed steel tube. His latest investigations have been concerned with the catalytic action of iron and copper oxides.

One circumstance which affects the course of the reaction is deserving of mention, viz., that if the oxide be heated to a high temperature before use, its efficiency as a catalyst is greatly impaired. This effect seems to be due, not so much to the production of a different surface, as to the elimination of moisture, for in the presence of the latter the reduction is stated to be facilitated. Its influence may be explained on the assumption that the water reacts with the oxide to liberate active hydrogen. As might be expected, there are many chemists who think that under the conditions of the process the oxide is reduced to the metal, which latter really functions as the catalyst.

It is unnecessary to mention any of the many accomplishments of the method, for it possesses no advantage over the preceding method except in its application to the reduction of compounds which demand a high compression of hydrogen. Naturally its dangerousness precludes the industrial development of the method. Very recently, by satisfactory industrial tests, Bedford has asserted the superiority of oxides of nickel over the metal itself, employed, however, without high pressures of hydrogen. The oxides are stated to be much less sensitive to certain impurities, and the hydrogenation proceeds with greater velocity than with nickel itself.

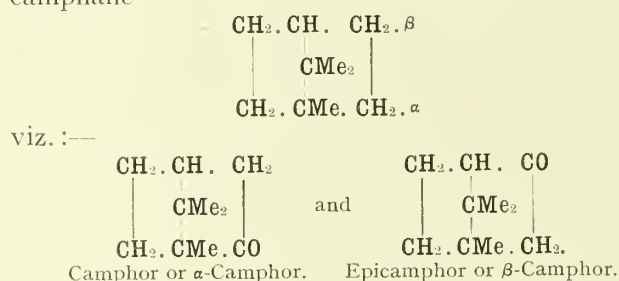
(To be continued.)

The Austrian Minister of Labour has decided to increase the radium production at St. Joachimsthal from 5 gms. to 10 gms., which represents an increase of value from 2,500,000—5,000,000 kr.

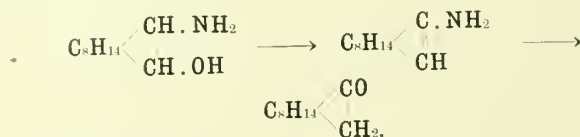
NOTES ON RECENT THEORY AND PRACTICE.

By HERBERT H. HODGSON, M.A., B.Sc., PH.D.

A MOST important investigation leading to the discovery of 1-epicamphor (1-β-Camphor) and to its preparation in large quantities has been carried out by Breddt and Perkin, who joined forces for this purpose (*Chem. Soc. Trans.*, December, 1913, 2179—2225). Two different keto substitution derivatives are possible from the fundamental hydrocarbon camphane—



Breddt originally suggested the first of these formulæ for camphor, and the correctness of this view has received abundant substantiation in recent years. The other possible isomere—epicamphor—must, therefore, in the language of the authors, be a substance whose importance from the chemical standpoint can hardly be less than that of camphor itself, and the study of its reactions and decompositions might be able to afford clues to the constitution and relationship of some of the more complex derivatives of camphor, data which can hardly be obtained, or at least not so readily, from the study of camphor itself. Repeated efforts have been made, but hitherto without success, for the preparation of epicamphor. For example, in 1900 Duden and Macintyre started with isonitroso camphor, reduced it to amino-camphor, then to amino-borneol, and proposed to remove water from the latter substance to obtain 1-amino-bornylene, from which, by the action of nitrous acid, 1-epicamphor should result :—

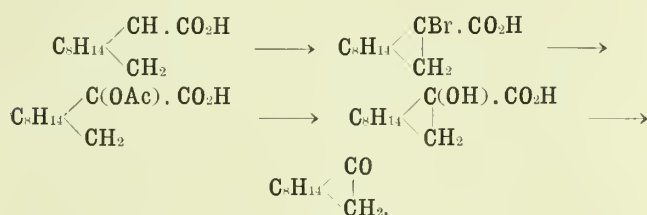


It was, however, found impossible to remove water directly from amino-borneol, and the base was therefore treated with phosphorous pentachloride yielding α-chloro-β-amino camphane, a substance which might be expected to yield amino-bornylene by elimination of hydrochloric acid :—

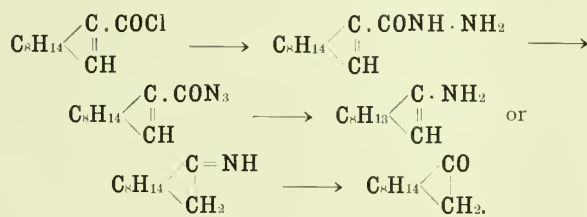


Elimination of hydrochloric acid did actually take place when the chloroamine was distilled with aqueous sodium hydroxide, but the base produced was not amino-bornylene, since, in place of epicamphor, it yielded a substance having the properties

of an unsaturated tertiary alcohol when treated with nitrous acid, showing that intramolecular change must have taken place during the elimination of hydrochloric acid. The first published account of the preparation of l-epicamphor is contained in a notice by Lankshear and Perkin (*Proc. Chem. Soc.*, 1911, 27, 167), in which the substance is shown to be obtained from d-camphane-3-carboxylic acid by the following series of operations: The chloride of this acid is treated with bromine, the product poured into alcohol and the bromo-ester thus obtained digested with potassium acetate in acetic acid solution. After hydrolysis with alcoholic potash, the crude α -hydroxy-3-carboxylic acid is oxidised by lead peroxide, permanganate, or chromic acid, when l-epicamphor results according to the scheme:—

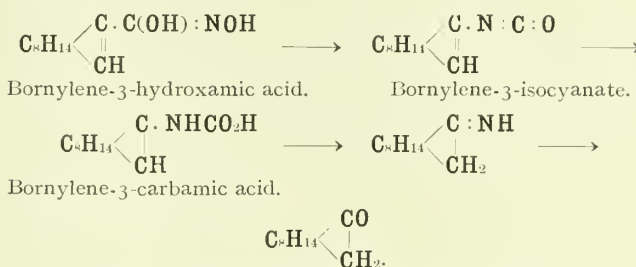


While Perkin's researches were in progress, Bredt and his co-workers had also succeeded in preparing l-epicamphor by a different method, and a preliminary account of their investigation appeared in the same year (*Chem. Zeit.*, 1911, 35, 765). The latter process was the conversion of d-bornylene-3-carboxylic acid, through the acid chloride, into the hydrazide, which, when subjected to the Curtins method, yielded the azide, and from this, by boiling with hydrochloric acid, l-epicamphor was obtained:



Perkin and Bredt now co-operated, and the current publication represents the result of their joint work. Of the above two processes, the azide method is much to be preferred, for not only do better yields occur, but also a purer product. It has this serious drawback, however, that there is always explosion risk during the formation and extraction of the azide, thereby compelling the operations to be on a small scale for safety. After repeated failure, a much more satisfactory process was evolved *via* d-bornylene-3-hydroxamic acid. The latter is produced almost quantitatively when methyl d-bornylene-3-carboxylate is treated with hydroxylamine in the presence of sodium methoxide, and is remarkable for the ease with which it is converted into l-epicamphor under a variety of conditions. When a small quantity of this acid is heated alone it decomposes just above its melting point with almost explosive violence, forming

epicamphor in part, although the principal product is a pale yellow transparent resin, which may be distilled, and which, in contact with hydrochloric acid and subsequent distillation in steam, gives a large yield of epicamphor. The authors explain this curious decomposition as due to the molecular rearrangement of dehydrated bornylene-3-hydroxamic acid into the volatile resin which is bornylene-3-isocyanate. The water produced during this process decomposes some of the isocyanate with formation of epicamphor and ammonia, while the remainder is decomposed in the same direction by subsequent treatment with hydrochloric acid and distillation in steam.



This and other pyrogenetic decompositions are unsuitable, owing to their violence, but the discovery that the acetyl and benzoyl derivatives of d-bornylene hydroxamic acid, which decompose in a similar manner, do so more quietly, and led ultimately to the working out of a valuable method for the preparation of epicamphor, which consists in bringing about the above-mentioned intramolecular change by the aid of toluene-p-sulphonyl chloride. Several hundred grams of l-epicamphor have been made in this way.

A synthesis of formaldehyde from carbon dioxide and water through the agency of inorganic colloids acting as transformers of light energy is the subject of a recent paper by Moore and Webster (*Proc. Roy. Soc.*, 1913, (B), 87, 163—176). These investigators have extended previous work on the same topic by Bach, Euler, Usher, and Priestley, and show that formaldehyde may be synthesised from carbon dioxide by means of uranic and ferric hydroxides (both inorganic colloids) in very dilute solution. These colloids act as catalysts for light energy, since positive results were only obtained in strong direct sunlight or when exposed to a "uviolet" mercury arc. Under similar conditions crystalloid uranium nitrate is non-reactive, while the uranium is more powerful than the ferric catalyst. The authors claim that such a process occurring in nature constitutes the first step in the origin of life.

The Russian Turpentine Industry.

In the course of a lecture before the Russian Technical Society, V. A. Kind stated that the turpentine industry in Russia dates back about 100 years, but until recently it was more or less a home industry. According to reliable estimates the turpentine output in the northern region amounts to about 100,000 poods per annum, while in the north-east district nearly 3,500 people are engaged in the industry.

SURFACE TENSION AND SURFACE ENERGY AND THEIR INFLUENCE ON CHEMICAL PHENOMENA.

By R. S. WILLOWS, M.A., D.Sc., and E. HATSCHEK.

CHAPTER V.

WE have so far succeeded in establishing connections between surface tension and a number of physical properties, but have not yet found a relation between the former and any chemical constant. A very simple and general relation of this kind was first pointed out by the Hungarian physicist Eötvös and confirmed experimentally, for a large number of liquids, by Ramsay and Shields. If M is the molecular weight of a liquid and ρ its density, then $\left(\frac{M}{\rho}\right)$ is proportional to the volume of a molecule.

$\left(\frac{M}{\rho}\right)^{\frac{1}{3}}$ is then proportional to the linear dimension of the molecule, and $\left(\frac{M}{\rho}\right)^{\frac{2}{3}}$ to its surface area.

Also, if σ , the surface energy per square centimetre of a molecule, is assumed to be the same as that of the liquid in bulk, the product $\sigma \left(\frac{M}{\rho}\right)^{\frac{2}{3}}$ represents the molecular surface energy. The Eötvös-Ramsay-Shields formula states that

$$\sigma \left(\frac{M}{\rho}\right)^{\frac{2}{3}} = K (\theta - \delta)$$

where θ is the amount by which the temperature at which σ is measured lies below the critical temperature.

The important point is that for $\delta = 6^\circ$, the value of K is the same—approximately 2.1—for a very large number of different liquids, independently of their nature.

In the case of some liquids—e.g., water, acetic acid and others—however, divergent values of K are obtained. Thus if we apply the formula to water at 0° , when $\sigma = 75$, $\rho = 1$ and $\theta = 365$, and if we put $M = 18$, we obtain a value of K much smaller than 2.1. But σ has also been determined between 100° and 200° ; if we introduce the values found in that range for σ and ρ and put $M = 36$, then K becomes approximately 2.1. This is interpreted to show that at the temperatures selected water has the molecular weight 36, or that it consists of aggregates containing two molecules on the average. Similarly, if K is to have its normal value below 100° , M must have a value between 36 and 54, i.e., water at these temperatures must consist of aggregates some of which contain two and some three molecules. Whenever K has an abnormally low value the liquid is thus assumed to be associated. Of course this is not the only possible explanation of the results, and there should be some confirmatory evidence of association, which must show itself in other anomalies, for instance, of density

and thermal expansion (water), or of density of solutions (acetic acid in water). Failing such evidence, other interpretations are possible; it might be that water is non-associated, but that its molecular surface energy is smaller than that assumed. On the modern view of the atom as a dynamical system it is also difficult to form any ideas as to where the surface energy has its seat.

The Eötvös-Ramsay-Shields formula represents the most important relation between surface tension and molecular weight so far established. A number of other and very interesting connections have, however, been pointed out by Walden in a series of papers published in 1908 and 1909, to which we can refer only briefly. In his equations the surface tension does not appear directly, but a constant derived from it—the introduction of which, although fairly general with German authors and although the constant has a definite meaning in Laplace's theory, has very little to recommend it. This constant is called the *specific cohesion* and is defined as $a^2 = \frac{2\sigma}{\rho}$

where σ and ρ have the usual meanings. Its dimensions are those of a surface, L^2 .

The principal relations established by Walden are as follows:—

$$(1) \quad \frac{L_b}{a_b^2} = 17.9$$

where L_b is the latent heat of vaporisation in calories, and a_b^2 is the specific cohesion (as defined above) at the boiling point. This formula holds good for normal, i.e., non-associated liquids; associated liquids give higher values.

$$(2) \quad \frac{ML_b}{v\sigma_b} = 3.64$$

where L_b has the same meaning as above; M is the molecular weight, v the molecular volume, and σ_b is the surface tension at the boiling point. This relation again holds only for non-associated liquids.

$$(3) \quad P = 75.3 \sigma_b$$

where σ_b has the same meaning as before and P is the intrinsic pressure. This relation is interesting on account of its great simplicity, but has little practical value, owing to the difficulty of directly determining the intrinsic pressure.

(4) By comparing the intrinsic pressures of various liquids and their solubilities in water, Walden finds that there is parallelism between the two. He also finds generally, although without establishing any numerical relations, that the mutual solubility of two liquids is the greater the smaller the difference of their intrinsic pressures; if this difference is very great the liquids are practically immiscible.

Two further relations introduce the melting point and the latent heat of fusion. They are:—

$$(5) \quad \frac{L_m}{a_m^2} = 3.6 \text{ (approximately)}$$

where L_m is the latent heat of fusion and a_m^2 the specific cohesion at the melting point.

$$(6) \quad \frac{Ma_m^2}{\theta_m} = 3.65$$

where M is the molecular weight, θ_m the absolute temperature at the melting point, and a_m^2 has the same meaning as before. This relation holds good only for non-associated liquids, and can, therefore, like the Eötvös-Ramsay-Shields formula, be used for determining the "association factor" of associated liquids. The results obtained by using the latter do not, however, agree in all cases with those following from Walden's formula; thus, benzene is associated according to Walden and non-associated according to Ramsay. The discrepancy is particularly striking in the case of sulphuric acid, which has aggregates consisting of as many as thirty-two molecules according to Ramsay, while Walden finds aggregates of two molecules only.

In connection with the melting point an interesting fact deserves mention, viz., that this constant varies with the size of the particles. This is a striking parallel to the variation of solubility with size discovered by Ostwald and Hulett, and referred to in Chapter IV. Thus, Pawlow finds that granules of salol with a surface of 230—1,300 μ^2 have a melting point 2.9° lower than particles with a surface 100 times greater, i.e., with ten times greater diameter,

(To be continued.)

ENGINEERING NOTES.

By R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

An Unusual Occurrence.

The writer met the other day with a phenomenon which is possible in all works where steam is raised, but which is nevertheless of very infrequent occurrence.

It completely mystified everyone connected with the works, and for the matter of that, the local electricity supply corporation's officials, who were at once summoned, and a satisfactory explanation was only arrived at on calling in the firm's electrical consulting engineer.

What happened was as follows: About 8.30 p.m., when the works were empty but for the caretaker and some annealers, the jointing of the main steam lead from a large Lancashire boiler blew out of the first joint above the boiler, the roar of steam escaping at a moderately high pressure immediately attracted attention, and the foreman fitter and the smith who both lived near were immediately summoned.

After the first rush of steam was over and the pressure in the boiler reduced they decided, in order that the boiler might continue to supply steam the next day, to bind a heavy brass strip round the joint, packing asbestos mill-board between the edges of the two flanges of the joint and the brass clip bands.

On going on top of the boiler to do this—part of the

boiler near the joint being bare of lagging—they both, on touching this and a neighbouring metal roof stay, received a very severe shock. On getting off they also noticed a luminous discharge between this part of the boiler and a damp plank a few inches above it. There was no electric circuit within 20 yards of the boiler, but at a slightly greater distance there was a lighting circuit, and at about 30 yards away a power circuit of 5,500 volts. At this stage from some unknown cause a fuse on the lighting circuit blew and the lights went out. The electric supply corporation officials were telephoned for, and on arrival renewed the lighting fuse and the circuit worked as usual. The band was now clipped on the joint, slight shocks being experienced, and the boiler successfully steamed till the week end. During the next day careful earth tests were taken on all the lighting and power circuits, but these all appeared to be in perfect order, and, in any case, there were so many good "earths" between the boiler and either circuit that, in spite of the shock and discharge, any connection between the two seemed from the first to be out of the question. The occurrence, however, seemed sufficiently serious and unusual to call for expert opinion, and the view obtained, which fitted all the facts, was as follows: The boiler was lagged and set in the usual way, the joint, as joints sometimes do, blew a rapid discharge of steam, dry through being wire drawn from a considerable pressure, impinged with considerable friction on the dry and warm surroundings, among others the exposed boiler top. The setting, lagging and flue dust, together with pipe joints, made a moderately effective insulation, and the result was a very fair low potential Leyden jar on a very large scale, charged electrostatically with frictional electricity. Luckily the insulation was by no means perfect and the time before an attempt could be made to fix the clip band some hours after the first rapid discharge of steam, or the two men engaged would certainly have been killed.

The electrical consultant informed the writer that he had come across three other instances almost exactly similar, and on one occasion had had the good fortune (?) to be present and, in trying to estimate the potential to which the boiler had attained, received a pretty severe shock. The blowing of the lighting circuit fuse was apparently a totally unrelated coincidence.

Chemical Factor in Safety of Aeroplanes.

A short time ago a communication from the Advisory Committee for Aeronautics to the War Office was published in *Flight*. This communication dealt with aeroplane factors of safety, and a thesis of this sort with the present state of our knowledge on the subject is plainly about as difficult as flying itself.

Flying machines cannot themselves, or in their several members, be tested for their factors of safety in the way that a ship or a steel girder bridge can: the load in practice is never a static one, and the load in flight must of necessity be very hard to state in terms of a static load of any kind, whether hung to or superimposed on various parts of the aeroplane framework.

It is true that ordinary tensile, bending and elongation tests can be taken, of most of the tubes, rods, angles and wires which form a large part of the structure of both airships and aeroplanes, but the very jerky and complex stresses to which these members will be subjected during flight introduce complications.

It is estimated that the static load equivalent to the stress produced by meeting a gust while banking may be six times the weight of the machine, or even more. But

the machines have to be made light for the power available, and, therefore, a strength giving an ordinary engineering factor of safety of four or five times this amount is at present altogether out of the question. The interest to chemical engineers and metallurgists, of course, chiefly lies in the discovery of a suitable metal which, while being exceedingly light, shall be strong and but little affected by climatic conditions; it would be unsafe to say ordinary climatic conditions, for a more complete method of chemical and physical scrubbing than flight could scarcely be devised. Aluminium and magnesium, of course, recommend them-

selves at once on the ground of lightness, but they could not be considered strong or even moderately resistant chemically to the weather as they stand, and so were never very seriously considered. Various alloys of these and other metals, but chiefly of these two, have since been suggested and tried, but most of those which presented a high tonnage showed little or no elongation and poor chemical resistance, and a perfectly satisfactory material in the above respects is still to be found. A very good one has, however, been evolved, and one which fulfils all the conditions to a certain extent and two of them exceedingly well—to wit, Duralumin.

REVIEWS OF BOOKS.

“THE PRINCIPLES OF INORGANIC CHEMISTRY.”

By Wilhelm Ostwald. Translated by Alexander Findlay. Fourth Edition. MACMILLAN & CO., LTD., London, 1914. Pages 836 + xix, with Index. Chapters XLVIII., with 131 Illustrations. Price 18/- net.

THE fourth edition of this valuable text-book, which now runs to some 800 pages, will be welcomed by all, because of the careful selection of the subject-matter, and its arrangement.

Some forty-five chapters are devoted to its classification, and include such important matters as substances and mixtures, laws of conservation, change in physical state, solutions, combustion, the elements, including those exhibiting radio-activity, and the choice of combining weights and the periodic system.

To those who do not yet know this work it may be recommended without reservation, while the large number of readers who have known it in its English guise will welcome this new edition of one of the most reliable and important text-books ever published in connection with general chemistry.

“X-RAYS. AN INTRODUCTION TO THE STUDY OF RÖNTGEN RAYS.”

By G. W. C. Kaye. LONGMANS, GREEN & CO., London, 1914. Pages 252 + xix, with Index and Appendices. Chapters XIII., with 97 Illustrations. Price 5/- net.

This work gives the chemist just the kind of information he requires concerning the nature and action of X-rays. It is exceptionally well illustrated. The subject-matter is treated in thirteen chapters and five appendices, and a mere perusal of the same will at once indicate the debt which the world of humanity owes to the workers in this direction.

With the ever-growing attempt on the part of chemists and physicists to understand each others' work, and appreciate the methods adopted by each to unravel the skein of natural phenomena, this work undoubtedly plays its allotted part, for it places results before its readers in a thoroughly satisfactory manner. The author may rest assured that he has succeeded in his allotted task, and that this work will receive the welcome it undoubtedly deserves from a large circle of readers.

“PHYSICAL CHEMISTRY. ITS BEARING ON BIOLOGY AND MEDICINE.”

By James C. Philip. Second Edition. EDWARD ARNOLD, London, 1913. Pages 326 + vi, with Index. Chapters XIV., with 24 Illustrations. Price 7/6 net.

This text-book presents the methods and conceptions of physical chemistry as they apply in the direction of biology, and to the attacking of physiological problems. It originated in a course of lectures addressed to biological students. In this second edition a chapter is added on electromotive force, and a short account of Czapek's researches on surface tension is also included. The chapters on the colloidal solutions, the separation of colloids from their solutions, and adsorption are of special interest, and undoubtedly the author has succeeded in collecting into this text-book information which will have a special interest to the student in biology or medicine.

BOOKS, ETC., RECEIVED.

“*Alcoholic Fermentation*,” by A. Harden. Monographs on Biochemistry. Second Edition. Longmans, Green & Co., 1914. Pages 156. Price 4/- net.

“*Storage of Petroleum Spirit*,” by A. Cooper Key. C. Griffin & Co., Ltd., 1914. Pages 126 + ix. Price 2/6 net.

“*Introduction to the Study of Organic Chemistry*,” by H. T. Clarke. Longmans, Green & Co., 1914. Pages 484 + iv. Price 6/6.

“*Lehrbuch der Physikalischen Chemie*,” by Karl Jellinek. Ferdinand Enke. Stuttgart, 1914. Pages 732 + xxxvi. With 81 Tables, 253 Illustrations and 4 Portraits. Price 24 marks.

“*Die Chemische Analyse, Der Nachweis Organischer Verbindung*,” by Dr. L. Rosenthaler. Ferdinand Enke, Stuttgart, 1914. Pages 1070 + xviii. Price 34 marks.

“*The Elements of Chemistry*,” by H. Ll. Bassett. Crosby, Lockwood & Son, London, 1914. Pages 368 + viii, with Index. Divided into 4 Parts, with 27 Chapters and 31 Illustrations. Price 4/6.

“*The Fixation of Atmospheric Nitrogen*,” by Joseph Knox. Gurney & Jackson, London, 1914. Pages 112 + v, with Index and Bibliography. Divided into 11 Chapters, with 8 Illustrations. Price 2/- net.

"The Science of Knitting," by Ernest Tompkins. Chapman & Hall, Ltd., London, 1914. Pages 330 + xiii, with Index, 55 illustrations, and numerous Tables. Price 12/6 net.

"Fuller's Earth," by Chas. L. Parsons. Bulletin 71, Bureau of Mines, Washington, 1913.

PERSONAL AND OTHER NOTES.

SIR GEORGE KENRICK has offered £18,000 for the endowment of a chair of physics at Birmingham University, in memory of the late Dr. Poynting, the Professor of Physics.

The Drapers' Company has resolved to defray the expense, amounting to £15,000, of the new chemical laboratories at the East London College.

A preliminary announcement of the ninth International Congress of Applied Chemistry has been issued. The meeting will open on July 26th, 1915, and close on August 8th, and will be held at St. Petersburg, under the patronage of the Emperor. The hon. president will be D. P. Konovaloff, Assistant Minister of Trade and Commerce, while the president will be P. I. Walden. Local organising committees have been established in Moscow, Kieff, Warsaw, Riga, Bakou and other centres. To insure free passage into Russia, membership cards as well as passports must be shown on the frontier. The Council are Léon Lindet (Paris), E. Paterno (Rome), Sir William Ramsay (London), Fr. Stromer (Vienna), O. N. Witt (Berlin), Francois Sachs (Brussels), and W. H. Nichols (New York).

S. M. Jørgensen, formerly Professor of Chemistry at the University of Copenhagen, has recently died in his seventy-seventh year. He was lecturer at the university from 1871—87 and professor until 1908. He has published several valuable works on inorganic chemistry.

Dr. Josef Habermann, formerly Professor of Analytical and General Chemistry at the German Technical High School at Brünn, has died in his seventy-second year.

Herman Frasch, president of the Union Sulphur Co., who was awarded the Perkin's medal in January of this year in recognition of his valuable work in applied chemistry, died suddenly in Paris. He was a native of Wuerttemberg, but went to America when sixteen years old. In 1874 he established a laboratory, and two years later discovered a process for refining paraffin wax. He was also the inventor of the Frasch process for mining sulphur, and was responsible for the development of the Louisiana sulphur mines, which have made the United States the largest sulphur producer in the world.

Edquard Hanuise, formerly professor at the school of Mines at Mons and Public Chemist, has died at Nice, where he lived since his retirement in 1895. He was co-founder of the Association Belge des Chimistes of which he was president. In this capacity he presided over the first International Congress for Applied Chemistry. In 1896 he was elected vice-president of the Société Technique et Chimique de Sucrerie de Belgique, which office he retained for four years.

UTILISATION OF HEAT FROM SLAGS.

BY WALTER L. JOHNSON.

FOR many years past efforts have been made to utilise the heat contained in molten slags. Some four years ago Messrs. Bell Brothers began experiments with a view to utilising this source of heat. The Slag Power Co. were also engaged on similar lines. The two interests were amalgamated, and further experiments carried out by Messrs. Bell Brothers. This was arranged, and after numerous trials the problem has been solved.

The slag experimented with was ordinary Cleveland iron slag of the following average composition :—

SiO ₂	..	..	..	..	30.80
Al ₂ O ₃	..	..	..	..	22.43
FeO	..	..	..	..	38
CaO	..	..	..	..	35.48
CaS	..	..	..	..	3.75
MgO	..	..	..	..	6.23
MnO	..	..	..	..	.93

The temperature of the slag employed was about 1,500° C. On pouring this into water contained in a specially constructed vessel the slag granulates, whilst certain non-condensable gases are generated, having approximately the following composition :—

H ₂ S	..	..	..	..	29.00%
H	..	..	..	..	55.00%
N	..	..	..	..	16.00%

The amount of gas per volume of steam varies according to the quality of the slag, but on grey slag the average production may be taken as about 0.5%. Besides these gases a quantity of fine sulphur is produced. It was originally intended to utilise the steam generated from the slag in a low-pressure steam turbine for the production of power. It was found, however, that the presence of non-condensable gases referred to above rendered a high power vacuum impossible, and, although means were devised for successfully eliminating them, the sulphur difficulty still remained, and it was found impossible to completely separate it from the steam. Also when the sulphur was allowed to come in contact with the blades of a turbine it caused their rapid destruction, and stopped up the steam entrances.

For these reasons the method of using the steam directly in the turbine was impracticable, but the difficulty has been overcome in the present system by employing a heat exchanger, the "dirty" steam from the slag being used to generate clean steam, to supply the turbine. The sulphur is thus kept outside the working steam circuit and is easily removable from the exchanger when necessary.

The following is a description of the plant: A is the orifice through which the slag is run into the primary generator B. This generator, B, contains an upright revolving shaft with four blades, which keeps the water constantly rotating. When the slag drops through the seal, C, its velocity carries it well below the lip. Blast furnace slag, which floats for a time before rising to the surface, is carried beyond the orifice, A, and inside the seal by the rotation of the water (Fig. 1).

Copper slag sinks at once, the steam rises inside the seal. Blast furnace slag is elevated from the generator, B, and dropped through a second seal, D, by which time it is water-logged and sinks; it is again elevated and dropped into trucks. In the case of copper slag only one elevator is required.

The steam comes along the pipe, F, into the heater, G, and then into the calandria, H, which consists of a series of tubes, the water being inside and the steam outside the tubes. The dirty steam travels down to the bottom and thence on to the calandria, H, the steam passing the calan-

dria and converting the clean water inside the tubes into steam; and permanent gases in the steam are drawn off by the pipes, J.

The calandria, a Kestner single-effect climbing film evaporator, consists of two parts, namely, the calandria and the separator. The calandria is composed of a shell or casing containing the evaporating tubes. The tubes are about 23 ft. long and fixed into the upper and lower tube plates. The water is fed into the apparatus at the inlet, K, and passes from the heater, G, into the separator, L, by the pipe, M. The dirty steam enters the calandria at N, having first passed through the heater.

The water begins to boil in the tubes because they are surrounded by the steam, and as ebullition takes place a column of vapour rises up the centre of the tube.

This vapour travels at a high velocity, and at the same time draws up a film of water on the inner surface of the tubes.

The water does not "climb" (as has been suggested) by capillary attraction or because of the liquor and steam forming alternate links in the same way as a Pohle air-lift works. The operation is performed in a simple manner; the water begins to boil in the tubes, and is gradually drawn up in a complete film by the vapour itself. As a result of this action a certain amount of water is carried up into the separator, L, which acts as a steam drier; the water, together with the feed water from the heater, which enter at O, flow down the pipe, P, and enter the calandria at the bottom. The steam is drawn off at the pipe, R, and enters the turbine, S, and so on to the condenser.

Copper Slag.—By experiment it has been found that 1,000⁰ kilos. of slag contain from 318—350 calories of

Allowing 25% loss, which is very liberal, there is still available 218,700 calories, and this divided by 537 *plus* 85 (water at 15° C.) = 622 = 351.6 kilos. of steam.

From very numerous experiments it has been found that the calandria gives an average efficiency of 91%, but taking this at 80% there is 281.3 kilos. of clean steam available for the turbine.

The turbine makers will guarantee to use not more than 12.3 kilos. of steam per horse-power with 28.5 ins. of vacuum and a vacuum of 7 ins. over the water in the calandria. Taking the steam consumption as 13 kilos., there is per 1,000 okilos. f slag 21.5 H.P., say 21 H.P.

Blast Furnace Slag.—By experiment it has been found that 1,000 kilos. of slag contain 550 calories of available heat, and upwards of 740 kilos. of water have been evaporated per 1,000 kilos. of slag.

1,000 kilos. of slag contain 550 calories
per kilo. = 550,000 calories

From this must be deducted—
1,000 kilos. $\times$ 100 $\times$.18 = 18,000

And, taking the worst case
where 50% of the
water goes away with
the slag, then—

500 kilos. $\times$ 84. . . = 42,000

60,000 60,000 ..

The available heat is 490,000 ..

Allowing 25% loss there remains .. 367,500 ..

And this divided by 622 gives .. 590.8 kilos.

of steam. Again, taking the efficiency of the calandria at 80%, there remains 472.7 kilos. of clean steam, and with a consumption of 13 kilos. per horse-power, there is available 36.35, or, say, 36 H.P. per 1,000 kilos. of slag.

As the conditions at each plant are so diverse it is impossible to estimate the cost, but where slag is already being granulated, the only extra cost in the case of blast furnace slag is the second elevator; one man per shift is required to look after the running-in spout, and moving the trucks; this applies also to a copper plant.

Below are given figures showing the cost per kilowatt of a 1,000 kw. plant with 75% load using the heat from slag, and the cost of a similar plant using coal at 14s. 6d. per ton:—

Waste Heat Plant. High-Pressure Plant.

	a.	d.
Granulator—Wages ..	.005	—
Repairs ..	.005	—
Interest and redemption ..	.010	Coals .210
Generator—Wages ..	.092	.092
Water, etc. ..	.021	.021
Repairs ..	.057	.057
Interest and redemption ..	.100	.100
Royalty ..	.030	—
	.32	.48 per kw.

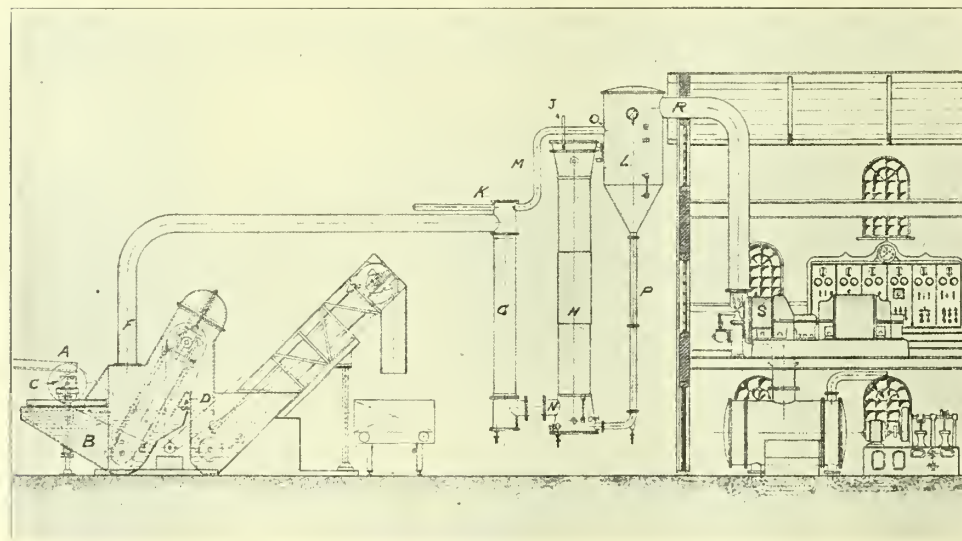


FIG. 1.

available heat, and upwards of 500 kilos. of water have been evaporated per 1,000 kilos. of slag:—

Taking the lower figure, viz., 318 calories, then—

1,000 kilos. $\times$ 318 calories gives .. 318,000 calories

From this must be deducted the heat taken
away in the slag at 100° C.—

1,000 kilos. $\times$ 100° C. $\times$
.18 specific heat .. = 18,000

And, say, 10% moisture—

100 kilos. $\times$ (100° - 16°) = 8,400 26,400 ..

Actual heat available = 291,600 calories.

or a saving on the waste steam plant of $\cdot 16d.$ per kilowatt.

On a plant of 1,000 kw. with 75% load the saving would amount to £4,300 per annum.

Apart from this saving there is a further advantage in this system. The water used in the primary generator need not be clean. The upkeep of the calandria and primary generator are small because the plates and tubes are not subject to great difference in temperature, as the slag goes directly into the water, and hence only steam at 100° C. comes in contact with any part of the plant.

The gases exert no action on the tubes or plates of the calandria, or heater, provided they are kept clean.

CORRESPONDENCE.

COLOUR OF METALS AND ALLOYS.

To the Editor of THE CHEMICAL WORLD.

SIR,—The article on a method of obtaining a measure of the colour of metal and alloys, on page 132 of your May issue seems to me to be a very unfortunate extension of the application of photography to technical purposes.

The mere attainment of a numerical measure of a quantity is of no value unless the quantity so obtained is strictly defined, and the method by which it is obtained is free from systematic errors. Mere concordance of results indicates only that the operations leading to those results have been repeated in the different trials with the accuracy indicated by the concordance, and in order that numbers obtained in a series of measurements shall be of real value, it is essential that they shall be measurements of one defined variable only.

Inasmuch as it is impossible to represent colour by a series of numbers representing degrees of only one variable, it is obvious that the numbers given by Messrs. Thompson and Sinkinson for the colour of metals cannot possibly represent a quantity which could accurately be termed "colour," however useful they may be to the authors themselves when dealing with one series of metals.

All methods for the measurement of colour involve the determination of at least two variables, these variables being the dominant hue of the colour expressed in wave lengths, and the percentage of admixed white. Thus the hue and percentage of white of several metals is as follows:—

Metal.	Hue.	% White.
Silver	Indeterminate	100
Gold	591	44
Copper	598	65
Cast brass	588	60
Rolled brass	575	60

In order to specify the surface appearance of a metal, in addition to the measurement of colour, the reflecting power should be measured on an absolute reflectometer. The measurements given above are made on the Nutting colorimeter, but similar numerical results in terms of three variables can be obtained on the Ives type of colorimeter, in which three primary colours are mixed to match the colour. The only disadvantage of this type compared with the Nutting instrument is that the numbers obtained are dependent on the colour of the filters of the colorimeter, and are, therefore, not expressed in physical units.

If the use of one or other of these colorimeters is held to be too complicated, and it is felt that all that is required

is a measurement of the "yellowness" of a metal, that is, practically of the admixed white as expressed in the examples given above, then a numerical expression of this may be obtained by the measurement of the reflecting power for the metal for two different points in the spectrum—one in the red, and the other in the blue.

The metal would first be illuminated by an arc lamp with a red filter, and the reflecting power against a standard, such as standard silver, measured, and then the red filter changed to a deep violet filter; or better, a mercury quartz lamp with a blue filter be substituted, and the reflecting power for blue violet light against the standard be measured; the ratio of the two measurements of reflecting power would represent the "yellowness" of the metal.

The application of photography for the measurement is undesirable, because it is extremely difficult to apply photography to photometric work under any conditions, and although for certain purposes, owing to difficulties in direct photometry, the use of quantitative photographic methods is necessary, it should be avoided wherever visual methods can be directly employed.

The introduction of errors due to the light source, to the sensitiveness of the photographic material, to the coating of the plate, to the development, and to the measurement of density, instead of the single error involved in the determination of direct reflecting power, always renders it inadvisable to use the photographic method; but it seems to me especially unfortunate to use it for the determination of colour, for which the photographic process, which makes no distinction between intensity and colour, is peculiarly unsuitable.

Yours truly,
C. E. KENNETH MEES.

Rochester, N.Y.

May, 1914.

THE DETERMINATION OF HUMUS IN HEAVY CLAY SOILS.¹

By WILLIAM BEAM, M.D., F.I.C.

Research Chemist, Wellcome Tropical Research Laboratories, Khartoum.

In a previous note on this subject,² attention was called to the great difficulty which had been experienced in carrying out determinations of humus in heavy clay soils, and the serious inaccuracy of the results obtained by the various methods which have been proposed. The results of an extended series of experiments led to the following conclusions, which were given as a summary of the article mentioned:—

- (1) In the case of heavy clay soils and especially those containing little organic matter, washing with water until the filtrate is neutral cannot be relied upon to remove the excess of hydrochloric acid remaining after the extraction of the calcium.
- (2) The form of filter best suited to the complete removal of the acid, and also to the ready and complete extraction of the humus by ammonia, is that furnished by a Buchner funnel and the use of a layer of asbestos as well as a supporting disc of paper. The soil should be mixed with sand and the mixture covered by a layer of sand and a protecting disc of filter paper.

¹ Reprinted from *The Cairo Scientific Journal*, 85, Vol. VII., 1913.

² *The Cairo Scientific Journal*, 68, Vol. VI., 1912.

- (3) The removal of the hydrochloric acid is best accomplished with a cold solution of carbon dioxide, in order to avoid puddling the clay. In cases in which the humus is very low the use of carbon dioxide water and the filter described above was found to be the only practicable method of carrying out efficient filtration.
- (4) Complete extraction of humus from soil can only be accomplished by repeated treatments with the ammonia solution. Methods depending upon a single extraction with a measured volume of ammonia yield results below the truth.
- (5) The removal of clay from suspension in humus solution is readily accomplished by the use of ammonium carbonate, as suggested by Rather, but the clay so precipitated carries with it a portion of the humus.
- (6) With suitable precautions the use of ammonium carbonate offers a reliable and satisfactory method for removing the clay from the humus solution.
- (7) For the reasons given in (4) and (5) the modified "official" method suggested by Rather may, in the case of soils poor in humus, give results as much as 50% below the truth.
- (8) Unless the greatest care is taken to avoid too long heating of the dried humus residue, and frequently notwithstanding such care, the Mooers-Hampton method fails when applied to Nile soils. Complete solution in ammonia after evaporation to dryness, cannot always be effected.

In continuing this work, certain soils were encountered which were difficult to treat even by the method of washing with carbonic acid water; and in searching for the cause of this condition it was found that the strength of the acid employed for the extraction of the magnesium and calcium has a very marked effect upon the rapidity of the subsequent filtration, when the washing is performed by water or by carbonic acid solution. The stronger the acid used for the extraction, the greater the difficulty experienced with the operation of washing. The use on the other hand of a weaker acid than that of 1% commonly employed, results in a marked advantage in this respect; but it was not found practicable, as a rule, to carry the dilution below $\frac{1}{2}$ % (i.e., 1 c.c. of strong acid to about 200 c.c. of water) since the extraction of the calcium and magnesium may be incomplete, the proportion of humus found being, in such cases, below the truth.

A still further improvement was effected by substituting for the solution of carbonic acid a very dilute solution of hydrochloric acid—about one-fiftieth of 1% (one part of the above-mentioned $\frac{1}{2}$ % acid diluted with water to twenty-five parts).

It was found possible in some cases to use a still more dilute acid for the purpose but, generally, it is safer to employ strength given, since some soils yield a filtrate coloured by organic matter if the dilution is carried beyond this point.

The use of such dilute hydrochloric acid for the washing has enabled us to treat all classes of soils with ease and certainty. In its presence the clay is kept in a finely flocculated condition and the extraction with ammonia is far more easily effected than when carbonic acid solution is employed. Further, the latter was found to be difficult to use in the hotter season, since the liquid must be kept cold in order that gas may not be liberated in the filter,

the disturbance of which results in the passage of a turbid filtrate.

Under the above conditions the quantity of chloride retained by the soil, and subsequently extracted by the ammonia, is very slight. Its exact amount must of course be determined on an aliquot portion of the ammoniacal humus solution and the results corrected accordingly.

The details of the method of humus determination as now carried out, are as follows:—

The filter is prepared by placing a disc of filter paper (S. & S. 598 is suitable) in a Buchner funnel of 10 cms. diameter attached to an exhaust pump, moistening with water and then turning on the exhaust until the greater portion of the water has been removed. A thin layer of asbestos may be employed in addition to the paper but is not usually necessary since the use of hydrochloric acid throughout the extraction and washing results in so complete a flocculation of the clay that at most only a very small quantity passes through the filter.

When most of the water has been removed, a mixture of 7.5 gms. of the soil with 15 gms. of finely granulated quartz is emptied into the centre of the filter and distributed, in as even a layer as possible, by means of a camel-hair brush. This operation must be performed quickly in order to avoid wetting the soil, which would prevent its even distribution.

The soil should be in a fairly fine state of division but not in fine powder. That which will not pass a 60-mesh sieve should be crushed in the mortar.

The quartz used should be prepared by powdering and rejecting the powder which passes a sieve of 120 mesh. The remainder (after extraction with acid followed by ammonia, washing and drying) is separated into a finer and coarser fraction by means of a sieve of 60 meshes to the inch. By using powdered quartz in place of ordinary extracted sand we have found the ash of the humus to be reduced from 0.5—0.2 % and usually even less.

After the soil and fine quartz has been well distributed over the filter, it is covered with a layer of about one-fourth of a centimetre of the coarser quartz and the whole covered with a filter of 11 cms. diameter which is moistened with water in order to permit of more ready adjustment. The filter is held in place by the weight of a number of sections of glass rod, bent at an angle.

The extraction of the calcium and magnesium is performed by means of $\frac{1}{2}$ % solution of hydrochloric acid (i.e., one part of the strong acid diluted to 200 parts with water) and should be continued until no trace of calcium can be detected in the filtrate. Usually about three hours extraction is sufficient. It is advisable to supply the acid continuously to the filter from a bottle provided with a stopcock, the flow being adjusted so that the acid is maintained at a height of about 1 cm. above the level of the paper filter.

When the filtrate is free from calcium, the acid is displaced by a weaker one (one part of the $\frac{1}{2}$ % acid diluted to 25 parts). The funnel need only be about two-thirds filled, and then allowed to drain.

Except at the start, when the filter is being made, the above operations are carried on without the use of the filter pump.

The humus extraction may be made with 4% ammonia. In our hands particularly identical results have been made from 4, 8 and 16% ammonia, if the soil is in a properly flocculated condition. Usually it is best to aid filtration by means of a pump and *very light* exhaust (about 3—5 cms. of water). The exhaust is controlled by attaching to the

pump a tall glass cylinder half full of water, the cork of the cylinder being perforated with two holes through one of which passes an adjustable air-inlet tube which extends into the water to a depth which is dependent upon the degree of exhaustion desired. If too great an exhaustion is attempted the filter quickly chokes.

Extraction of the humus, from a soil prepared as above, takes place very rapidly, and the liquid usually comes through quite colourless by the time 200—300 c.c. of filtrate has been collected. As a rule the filtrate appears quite clear, but this appearance is often deceptive and it is necessary therefore, in all cases, to treat with a small amount of ammonium carbonate, as recommended by Rather, to precipitate the clay. 0.5 gm. of the salt is used for each 100 c.c. of the ammoniacal solution. The proportion of humus carried down by this small amount of clay is negligible.

The liquid, after being made up to definite volume, and mixing, is either allowed to stand over night, or stirred for a few minutes and centrifuged. The latter is a very convenient method. A proportion of the clear liquid corresponding to, say, two-thirds of the total, is evaporated in the usual way for the determination of the humus. The proportion so found must of course be corrected for the ammonium chloride present. The remainder of the humus solution is treated with about 5 c.c. of a decinormal solution of sodium hydroxide, evaporated to dryness, ashed at low temperature over a spirit lamp, the ash dissolved in a little water acidulated with nitric acid, the excess of acid neutralised by calcium carbonate, the solution filtered and the chloride in the filtrate determined by titration with silver nitrate.

Influence of Strength of Ammonia Solution.—Alway, Files and Pinckney¹ found that, working with ammonia solutions between 2 and 5%, the differences in the amount of humus extracted were slight; but that when solutions of 16% and over were used, considerably more humus was extracted. In our experience, and speaking only of Nile soils treated in the manner indicated, there is no marked difference in result up to 16% concentration, *provided the soil is in a properly flocculated condition*. When this is not the case the stronger ammonia may lead to higher results, but this is simply to say that the weaker ammonia may still further puddle the clay, and render the extraction less complete.

The following are some of the results obtained :—

Strength of Ammonia.	Soil.					
	Managil.	Gezira.	Research Farm.	White Nile.	Zeidab.	Sobat.
4 per cent.	0.46	0.42	0.42	0.62	0.24	1.23
8 per cent.	0.49	0.41	—	0.60	—	—
16 per cent.	0.45	0.42	0.40	0.60	0.26	1.21

*Modification of the "official method" proposed by Rather.*²—As noted above it was found that the complete extraction of the humus could only be effected by repeated treatments with ammonia; and, further, that while ammonium carbonate may be employed for the precipitation of the clay, if the latter is in great excess an appreciable

amount of organic matter is carried down with it. For these reasons the modified official method proposed by Rather may yield results below the truth. The extent of error which may result in the case of Nile soils is shown in the following Table, in which method (A) is that recommended above and (B) the modified official method suggested by Rather :—

Soil.	Gezireh E.	Managil.	White Nile.	Tayiba.	Sobat.
Humus, per cent., method (A).	0.36	0.46	0.62	0.42	1.23
Humus, per cent., method (B).	0.25	0.37	0.46	0.29	1.03
Average, (A)			0.618		
,, (B)			0.480		

It is interesting to note that if, in the modified official method, the washing out of the acid is effected by the use of one-fiftieth per cent. of hydrochloric acid, practically the whole of the chloride in the ammoniacal extract is carried down with the clay when the solution is treated with ammonium carbonate.

Colorimetric Estimation of Humus.—In the former note on this subject, already referred to, attention was drawn to the fact that the humus of Sudan soils appeared to be capable of very accurate estimation, colorimetrically. Further experience has confirmed this conclusion. In the case of soils of approximately the same composition as regards proportion of clay and humus the latter may be determined by direct boiling with $\frac{1}{2}$ % sodium carbonate solution, preferably after previous boiling with distilled water in order to disintegrate the soil. Five grammes of the latter is treated with 400 c.c. of distilled water in an enamelled iron vessel and boiled for five minutes. Twenty cubic centimetres of a hot solution containing 2.5 gms. of sodium carbonate is then added and the boiling continued for exactly one minute. The liquid is cooled as rapidly as possible, made up to 500 c.c. and allowed to stand over night in a covered beaker. If not perfectly clear the supernatant liquid is filtered through an asbestos filter. A small Buchner funnel is suitable. The comparison is made with a similar soil of known humus content treated in the same way.

The most accurate results are obtained by treating the soil with acid, as in the gravimetric determination, followed by extraction with ammonia. The removal of the excess of hydrochloric acid is of course not necessary. Using this method the comparison may be made between soils of greatly varying composition both as regards clay and humus.

The following are some of the results obtained :—

Soils.	Gravimetric.	Colorimetric.
Gezira mixture . . .	0.42	Standard
W. Nile .. .	0.60	0.60
Sobat .. .	1.32	1.27

The first and third samples were taken from points over 500 miles apart, under very different conditions as regards rainfall, etc.

¹ Bulletin 115 Agric. Exp. Sta. of Nebraska.

² Journ. of Eng. and Ind. Chem., Sept., 1911.

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, Chartered Patent Agent,
Queen Anne's Chambers, Westminster, S.W.

18310/12. A. DE KADT. Manufacture of Fatty Acids.

In the manufacture of saturated compounds from unsaturated fatty acids or their esters, by subjecting the fatty acid or ester to the action of hydrogen in the presence of a catalyser, the catalyser used is a soap of a heavy metal or of a noble metal made from a fat or fatty acid having a melting point higher than that of the unsaturated compound to be produced.

6911/13. O. VOIGTLÄNDER. Tungsten.

For producing homogeneous bodies of any desired shape from pure tungsten, a mixture of tungsten trioxide and aluminium is placed in a crucible and then introduced into a highly heated furnace and burnt therein, whereby under the combustion heat of said mixture, combined with the heat of the furnace, the metal is melted and separated from the other products of the reaction.

7409/13. W. S. ROCKEY and H. ELDRIDGE. Refining Copper.

A process of refining copper consisting in melting same in a fusing chamber is characterised by the fact that the metal whilst in the solid state, whilst melting, when molten and until actually poured into a ladle, is refined and protected from oxidation by means of a covering of highly heated gases, products of combustion and products of gaseous and vapour decomposition.

8420/13. D. E. ROBBINS. A New and Improved Method of and Apparatus for Treating and Bottling Beer, Cider, Sparkling Wines and other Alcoholic Beverages.

8910/13. E. A. ATKINS. Galvanising.

In the coating of iron or steel with zinc in a molten state, the by-product or waste "zinc ashes" and "flux skimmings" resulting from the process of hot galvanising are used for the purpose of constituting a fluxing medium.

9176/13. S. L. ELBORNE and H. GODSAL. Gas Retorts.

Fireclay gas retorts are rendered impervious to the passage of gas by incipiently vitrifying clay of a less refractory character added or applied to the fireclay during the manufacture of the retort.

9451/13. C. TORLEY and O. MATTER. Improvements in the Process for the Production of Ethers of Monohydric and Polyhydric Substitution Products of Aromatic Hydrocarbons.

9988/13. V. B. LEWES. Improvements in or relating to the Carbonisation of Coal.

10281/13. H. BECKER and H. UNGER. Treating Domestic Refuse.

In a process for treating fusible domestic and other refuse for obtaining paving or building blocks, the refuse is separated into its coarse and fine constituents, and the fine constituents only formed into briquettes and fused with coke in a furnace, the iron being separated from the slag and the slag poured into appropriate moulds.

10687/13. G. CALVERT. Acetic Acid.

Acetic acid is manufactured by treating husks, such

as coffee husks, in a retort, drawing off the gases evolved, treating them for the removal of the acetic acid and any other products present, and then returning the treated gases, either in a hot or in a cool state, to the retort.

11617/13. A. MOLHANT. Fermentation Processes.

In processes of fermentation of molasses and other fermentable liquids, yeast or ferment of a pure or composite stock acclimatised to hydrochloric acid after having been previously accustomed to live in formulated mediums is employed.

12978/13. BADISCHE ANILIN UND SODA FABRIK. Hydrogen.

Hydrogen is manufactured by passing a hydrocarbon and steam over a nickel catalytic agent distributed on a fireproof carrier, the reaction being carried out at a temperature above 700° C.

13104/13. J. STEPHENSON. Coal Gas.

In a process of gas manufacture, a series of vertical retorts are heated by the combustion of a predetermined portion of the water gas produced by a water gas generator, combustion being effected by means of air which has been superheated by the heat evolved from the combustion of the producer gas led off from the generator.

14230/13. F. RASCHIG. Continuous Distillation.

In the continuous distillation of tar or other liquid, the liquid is conducted consecutively through a series of stills, each of which, after the first, is working at a lower pressure than, but substantially the same temperature as, the immediately preceding still.

16035/13. E. HERTER. Recovery of Zinc.

A method of recovering zinc metal from zinc ores consists in distilling the charge of ore and reducing agent in an electrically heated furnace, a vacuum being applied at the beginning only of the reduction process to withdraw the atmospheric air from the distilling chamber and concentrate the zinc vapours.

18382/13. G. RIGLER. Artificial Milk.

An artificial milk consists of fats emulsified in a liquid containing dissolved or swollen gluten and of suitable quantities of the inorganic salts forming the constituents of natural milk, together with sugar or other sweetening substance.

20712/13. A. E. BERRY and A. BOAKE ROBERTS & Co., LTD. Brewing.

Lactic acid is added to the otherwise untreated water employed for brewing purposes.

21385/13. H. KOPPELS. Improvements in the Process of Treating Sulphur-bearing Materials.

22297/13. E. DOUZAL. Artificial Marble.

Artificial marble is manufactured by mixing vaseline oil with a pasty mass composed of a mixture of an oxide and halide or basic halide of a divalent metal having a non-coloured oxide, water and calcium carbonate, adding a solution of acetate of lead to the paste thus produced and then moulding the same.

23740/13. SOCIÉTÉ GÉNÉRALE DES NITRURES. Aluminium Nitride.

A process of obtaining aluminium nitride by treating alumina or aluminous substances and carbon in an atmosphere containing nitrogen is characterised by the fact that the solid bodies are passed through a space filled with nitrogen and heated to the temperature of the reaction.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

Finnish Wood Products.

According to the *Financier* attention has for some time been directed to the decline in Finland of the manufacture of by-products in the wood-working industries. The organised production of charcoal, resin, tar, turpentine, wood spirit, etc., has been so excessively weak in Finland, at all events down to a very recent date, that the industry can almost be called extinct, or within measurable reach thereof.

Particular mention is made of the decline in the production of charcoal and the distillation of tar. Half a century ago these products occupied a prominent position in the foreign trade of Finland. In 1863 as much as 400,000 hectolitres of tar were exported of the value of 9,000,000 marks, at to-day's valuation. The export of resin then was greater than the export of pitch. Thus, in 1865, the value of the resin exported—at present day prices—was 1,000,000 marks. With the extension of the saw-mill industry, the distillation of tar, which had been conducted on quite primitive principles, lost its importance more and more for the timber people. The saw-mill industry and other wood-working operations produce a large quantity of waste, which would make excellent raw material for the purpose, but which at present goes practically to waste.

Ammonia Contents of Illuminating Gas.

The United States Bureau of Standards have issued a report, prepared by J. D. Edwards for the Bureau, presenting the results of an investigation of the appearance and methods employed for the commercial determination of ammonia in illuminating gas. The report says:—

"The method generally employed for the determination of ammonia in purified illuminating gas depends upon the absorption of the ammonia in a standard acid solution, the amount of ammonia absorbed from a measured volume of gas being determined either by titration of the acid remaining unneutralised or, less frequently, by allowing the gas to pass until a change is shown by the indicator used.

"The choice of the proper indicator to use for this determination is of greater importance than the choice of apparatus. The indicators which were found to be most suitable for the determination of ammonia in gas were sodium alizarinsulphonate, cochineal and parantitrophenol. The presence of glass beads which are used in some of the absorption apparatus may lead to erroneous results for two reasons: first, the beads may yield alkali on contact with the absorbing liquid; second, washing of the beads may be incomplete. It is recommended that the operator test the solubility of any beads he may use; the method of washing out the apparatus should also be tested."

Five different forms of apparatus were tested: Referees apparatus, the Emmerling tower, the Lacy apparatus, the common form of gas-wash bottle, and a modified form of the Cumming gas bottle. The relative efficiency, and from this the relative accuracy, of the different forms of apparatus was determined by running them in parallel, using gas from a common supply. As a result of this comparison it was found that the Emmerling tower gave

results which were somewhat higher than those obtained with the other forms, and that the wash bottle gave results consistently lower. With careful operation any one of the five forms of apparatus tested would ordinarily give results that are well within the limits of accuracy required for this determination, either for commercial control work, or for the purpose of gas inspection.

Coconut and Palm-nut Sugar.

In the *Centralblatt für die Zucker-Industrie* a note is made of the proposed production of sugar from palm nuts and coconuts, in which reference is made to previous experiments with palm kernels in the production of sugar as well as with coconuts. The sugar is more easily extracted from these nuts than from the sugar cane, as in the case of the latter very heavy machines are required to extract the sugar compared with the simple method required for dealing with the nuts. Besides this, the plants do not require fertilisers or any particular attention. The author of the article observes that the raw material may be taken by tapping the trees, and experiments showed that the flow of sap from palm trees may continue for as many as 70 days every year without danger of injuring them.

In an editorial remark to this article it is suggested that, if it be true that the tapping may be done to such an extent, it will in course of time become a serious competitor with the sugar cane as the raw material for sugar production. In the event of the coconut being used for this purpose, it must have a serious effect on the value of copra, for which a growing demand exists.

Increased Output of Sulphuric Acid in America.

According to actual returns made to the United States Geological Survey, the production of sulphuric acid in the United States in 1913 was 3,538,980 short tons of 50° acid, valued at \$22,366,482. This output does not include a small amount of fuming acid, but includes by-product acid, that is, acid obtained in the smelter industry. The acid produced at copper and zinc smelters in 1913 amounted to 790,296 short tons of 50° acid, valued at \$4,346,272. The year 1913 is the third for which statistics of sulphuric acid have been collected by the Geological Survey. The 1913 output of 50° sulphuric acid was 662,980 short tons greater than that of 1912.

The Position of the German Potash Industry.

The position of the potash industry in Germany is at present particularly interesting. The profitable nature of the business caused numerous new companies to take it up, with the result that considerable over-production is threatened in the near future. In order to prevent this the Government declared their willingness to introduce a new potash law which would, however, include an extra tax on the producers for revenue purposes. This proposal met with much opposition on the part of the older companies who wished to show the uselessness of the Government intervention by coming to an understanding among themselves to restrict the production. At first their efforts in this direction seemed to be successful, as several important houses declared their willingness to join the movement for

reducing the output. During the last few weeks, however, difficulties seem to have arisen with respect to the extent of reduction which the different concerns were expected to effect. According to the German Press, the position with regard to combined limitation of output is almost worse than some months ago, and it is considered best to wait for the new potash law, which has already been drawn up and been sent to the Reichstag, as this may impose conditions that would make any measures impracticable which the producers might have agreed to. M. L.

CONSULAR REPORTS.

Trade in Caustic Potash in France.

There are no official statistics available to show the production or consumption of caustic potash in France, but from trustworthy information from commercial sources it is learnt that the use of caustic potash has greatly decreased in France, for the reason that it has been replaced by a form of liquid potash, "titrée," that is of a certified strength. As nearly as can be ascertained the consumption of caustic potash in France does not exceed 900 to 1,000 metric tons, whereas the former annual production reached a total of 2,000,000 metric tons, only a small portion of which was exported. The principal source of supply is a firm with works at Paris, Pantin, Lyons, Amiens, Havre, Rouen, Orleans, Bordeaux, and Nantes. The average price varies, according to the degree of strength, from 39—45 francs per 100 kilos. The principal sources for imported caustic potash are Russia and Germany.

Business in Chemicals in Dresden.

Consul Palmié at Dresden reports that during the first half of last year the business in the chemical and pharmaceutical industries continued very good. Then, in consequence of the prolonged Balkan War, it began to decline, not so much in respect to the sale of medical drugs and chemicals as to the sale of those required in industry and technics. The supply of these latter soon exceeded the demand, and prices fell. The production of a number of articles had to be limited. This course having been adopted in time by the more important firms in anticipation of a weak market, the industry did not suffer too much by the change when it came. Foreign countries, with the exception of Mexico, the South American Republics and the Balkan States, were good customers, so that, on the whole, export remained at the same level as in 1912. Losses through insolvencies were very limited, and liabilities were, under the circumstances, well met by the Balkan customers. The wages of the workmen were again raised.

A Glycerine Factory in Mexico.

Vice-Consul G. E. S. Watson reports from Mazatlan in Mexico that a new glycerine-extracting plant has commenced business during last year and seems to have every prospect of success. The machinery is British, and the concern is under Spanish management. Last year's production was disposed of hurriedly in the United States and shipped by sea. With the re-opening of the railroad prospective purchasers in the United States propose sending tank cars to transport this product; this would seem to abolish the "returned empties" worries which otherwise would arise.

Chinese Salt Tax Yield.

The Exchange Telegraph is officially informed that the news has been received in London from the Peking Govern-

ment to the effect that the revenue from the Salt Gabelle far exceeds the estimate this year. The return up to the middle of April has been £16,500,000, averaging £4,700,000 a month, or £56,400,000 a year. After paying interest and sinking fund for all foreign loans secured by this source of revenue there is a surplus for the Government of about £3,000,000.

MARKET REPORTS.

THE trade returns for May reveal a further decrease of *exports* of chemicals, drugs, dyes, and colours, while the *imports* have increased. The exporters have, therefore, no cause for satisfaction, as the value of the May shipments amounted to £1,905,554 only, as compared with £2,089,768 during the corresponding period of last year. On the other hand, there was a gain of £43,619 to report in the value of imports. The principal items which contributed to the decrease of the exportation were the following: coal tar products (not dyes), which declined by £18,524; glycerine, the value of which fell from £132,587 to £38,552; chemical manures, which decreased by 5,652 tons and £96,784 respectively, and bleaching powder, which diminished by 30,411 cwt. in quantity and by £6,346 in value.

The home trade has experienced a slight improvement, which is, however, by no means general, and only refers to certain sections of the markets. The general tendency is still towards further contraction of business, a fact which is hardly to be wondered at, if one remembers that good and bad trade runs in cycles. The business in fertilisers is very dull and uninteresting. The available supplies of nitrate are much larger than twelve months ago. The news of a record output in Chile during May caused a depression in the markets, and the visible accumulation of stocks on the West Coast, in combination with the complete absence of buyers, helped the downward tendency. Ordinary qualities are quoted at £10 5s., and refined nitrate at £10 10s.—£11. Sulphate of ammonia is completely neglected, although the present prices are lower than they have been for many years. The export demand is most disappointing, while the home buyers also show great reluctance to do business. Gray 25% sulphate of ammonia, London prompt, has been offered as low as £9 17s. 6d., without attracting much attention. Tar products remain in a stagnant condition. Pitch is having a quiet time, and the present reduced output does not prevent a gradual downward movement of prices. Some buyers are prepared to place fair orders at 30s., but this is less than any maker will accept, and the lowest quotation is about 32s., or more than 10s. less than twelve months ago. The pitch consumption for road purposes is fair, though not quite so good as anticipated. Benzols have further quietened down, but there are no great stocks in the hands of the consumers. Continental buyers show very little inclination to do forward business, and the demand for prompt is confined within narrow limits. Fifty per cent. benzol is quoted the same as 90%, e.g., 11d. per gallon. Naphthas are neglected and weak, though solvent is scantily offered at 9½d. per gallon. Carbolic acid favours consumers who are prepared to buy 60% quality at 1s., which is about ½d.—1d. less than makers ask. Crystals suffer from the competition of the synthetic product, the low price of which prevents the former to rise above 3½d. per lb. Creosote represents one of the firmest sections of the market, as well as one of the most active ones. The price remains at 3½d. per gallon. Barium products are in fair demand at steady rates.

MANCHESTER. The market for heavy chemicals lacks

activity, and there are indications of a further shrinkage in the home consumption. This could hardly fail to influence the prices which, at present, keep fairly steady. Citric acid remains scarce, but the high prices demanded by the manufacturers preclude serious business. Acetates of lime are in moderate request at £5 12s. 6d. for brown, and at £24 15s. for white acetate. The demand from the textile trades is adversely influenced by the depression in the Lancashire cotton industry. White powdered arsenic is flat, and there is practically no inquiry for large lots at the current quotation, viz., £13 10s.—£14 10s.

LIVERPOOL.—The business in chemicals cannot be called active, although it has brightened up a little after the holidays. Sulphate of copper has been quiet and weak. Some transactions took place in forward delivery, but the interest in prompt is very feeble. The price has gone down to £20 15s. per ton for prompt, less 5%, in 4—6 cwt. casks, f.o.b., Liverpool. Bleaching powder is flat. Hyposulphite derived some benefit from a better demand, and the price is now £5 15s.—£6 per ton. Cream of tartar develops a firm tendency.

GLASGOW.—The home inquiry for alkali products is quiet, and hardly sufficient to test prices. The firm tendency of the lead market caused a corresponding hardness in lead compounds. The coal tar markets have shown increased dullness, and most articles tended downward.

Metal Markets.

LONDON.—During the period under review the copper prices established a new low record for the year by falling to £61 8s. 9d. for cash, but since then a slight improvement has taken place. The European copper statistics for the first half of the month were considered disappointing in market circles, as they showed an increase of 550 tons in the visible supply. The inquiry for all descriptions of refined and manufactured copper has not been stimulated by the recent reduction of prices. Home manufacturers are now rather eager to get fresh orders, and a revival in this direction would probably help the trade in refined copper. Standard copper closed at £61 15s.—£61 17s. 6d. for cash, and at £62 5s. at three months. The condition of the tin market has improved and appears more settled than for some time, but, in view of the large excess of supplies in recent months and the enormous quantity which is still forthcoming from the Straits, a permanent improvement of the prices seems hardly likely. The closing quotation for Straits tin, cash, was £137 15s., and for three months, £139 10s. Lead has been quiet, but the position of prompt lead was strong enough to support the whole market. Consumers are reserved, believing that freer arrivals during the next few weeks will ease prices. English refiners have sold sparingly at £20 per ton. Foreign lead for July was offered at £19 2s. 6d., and August at £18 15s. Spelter is unfavourably influenced by the reduced activity in the galvanised sheet trade. The quotation is nominal at £21 7s. 6d.—£21 12s. 6d., according to position.

FINANCIAL ITEMS.

THE report of Kynoch, Ltd., shows a profit of £122,475, and the directors recommend a dividend of 5%.

The Compagnie Française des Extraits Tinctoriaux et Tannants of Havre, which manufactures dyeing and tanning extracts from wood, reports that in 1913 it imported for manufacturing purposes 74,000 tons of dyeing and tan-

ning material, as against only 55,000 tons in 1912. The excess arose in large part from the increase in its sales of tanning material, a branch of its industry that is developing actively. The current year does not offer such favourable prospects as the last.

Aktiebolaget Alb. Goldbeck-Löwe, O.Y., has been incorporated in Helsingfors, Finland, with the object of taking over the wholesale business in chemicals and metals (lead, antimony, etc.) carried on by A. Goldbeck-Löwe. Capital, 200,000 marks.

Aix-la-Chapelle. Aktien Ges. Chemische Fabrik Rhenania will again distribute a dividend of 22%. In addition to this a special bonus of 10% will be given on account of the sale of the Rhenau works. A sum of 1,300,000 marks has been reserved for the purpose of erecting new works at Stolberg.

Frankfort-o.-M.—Deutsche Gold and Silber Scheideanstalt (German Gold and Silver Assaying Institution) report a fairly successful year, although the political situation in Europe and the tariff alteration in the United States acted adversely on the business. The net profits were about the same as in 1912, viz., 8,427,983 marks (8,418,394). A dividend of 30% on the capital of 20,000,000 marks has been proposed by the directors (the same as in 1912).

Chemische Industrie A.-G. at Bochum.—The sales and labour conditions in all sections of this concern were quite satisfactory during 1913. After writing off 575,000 marks (450,034) the net profits amount to 70,714 (22,303). The former deficiency of 220,111 marks is thus reduced to 149,396 marks. In view of the enlargements and improvements made at the works the directors feel justified in expecting a further increase of profits.

Fluorit, G.m.b.H., has been registered at Prague. Capital, 20,000 kr. Objects. To carry on the manufacture of technical and chemical compounds, especially of "Fluorit."

The Oesterreichisch-Ungarische Sauerstoff Werke, G.m.b.H., in Vienna, in combination with the firm of Muttoné & Co., have erected an oxygen factory at Brünn.

"Hermania" A.-G. vorm. Königl. Preuss. Chem. Fabrik at Schönebeck, have declared a dividend of 3% on the share capital of 1,600,000 marks (compared with 5% in 1912). The net profits were only 93,639 marks (113,000).

Chemische Fabriken Weiler-ter-Meer at Uerdingen will raise the capital by 2,000,000 marks to 8,000,000 marks. The net profits for last year reached 1,518,627 marks, and the dividend has been fixed at 12%.

Sicco A.-G. Chem. Fabrik in Berlin will increase the capital by 100,000 marks to 600,000 marks.

Chemische Fabrik Goldenberg, Geremont & Co., at Winkel, made gross profits of 349,798 marks (337,636) and paid a dividend of 14%, the same as in 1912.

The Austrian Glanzstoff-Fabriken, Vienna, which work the cupro-ammonium and viscose artificial silk processes in Austria, are again paying 10%. The Glanzfäden A.-G., Berlin, one of the newer artificial silk companies, have had a net loss of 24,380 marks, against a net loss of 125,640 marks in 1912.

NEW COMPANIES.

RUBBERINE, LTD.—Capital, £15,000 in shares of 5s. each. Object: To acquire and turn to account any invention relating to the solidifying and roughening of oils: to manufacture artificial rubber or substitutes therefor, to adopt an agreement with Rubberamalga, Ltd.,

and T. P. West, the liquidator thereof. For the said purpose a trust deed to secure 6% first mortgage convertible debentures described in and upon the terms of a draft trust deed has been prepared between the company and Sir Bindon Blood G.C.B. Registered office: Campbourne Mews, Hornsey, N.

COPPEN BROTHERS, LTD.—Capital, £76,000. Object: To take over the business of wholesale and retail chemists and druggists and general providers carried on by H. W. Coppen and G. S. Coppen at Carey Street, Vincent Square, Westminster, and elsewhere, as "Coppen Brothers," and at Richmond, Surrey, as "Coppen Brothers & Co" (an unlimited company).

BARNESLEY SMOKELESS FUEL CO., LTD.—Capital, £95,000. Object: To carry on the business of producers and manufacturers of and dealers in fuels of all kinds, whether natural or artificial, and whether in a solid, liquid, or gaseous condition, for domestic, commercial, industrial or other purposes; to carry on the business of distillers, extractors, manufacturers and suppliers of solid, liquid and gaseous substances or matter derived in any manner from coal by combustion, evaporation, distillation, decomposition or other means, whether physical, mechanical, or chemical; to produce sulphate of ammonia, benzol, tar, and other derivatives obtained from coal, etc., and to adopt an agreement with the British Coalite Co., Ltd. (the vendors).

MIES' ELECTRIC AND CHEMICAL CULTURE, LTD.—Capital, £10,000. Object: To take over certain patent rights relating to chemical culture, etc., and to carry on the business of agriculturists, chemical and fertiliser manufacturers, etc. Registered office: 37, Piccadilly, W.

ASSOCIATION OF MANUFACTURING CHEMISTS, LTD.—Capital, £100 in 1s. shares. Objects: To protect the members, customers and connections of the company against persons, firms and companies considered unworthy of mercantile credit, or otherwise undesirable; to procure and communicate to members status information; to collect debts, etc. Private company.

CARBIC, CANADA, LTD.—Capital, £130,000. Objects: To take over the Canadian patent rights granted or to be granted to Sir Charles Wakefield, or others, in connection with a process for the treatment of carbide of calcium and its manufacture into cakes, etc.; to carry on in Canada or elsewhere the business of manufacturers and sellers of carbic cakes or carbide of calcium in any form for lighting, welding, heating or otherwise, manufacturers of residual products obtained in the manufacture or treatment of carbide of calcium.

TRADE ITEMS.

THE LENNOX FOUNDRY CO., LTD., issue a new catalogue which indicates the rapid advance in the use of these alloys for acid-proof vessels. It is announced that a special alloy is now available for hydrochloric acid. Tantiron is now made "soft" enough to be machined in the ordinary way like cast iron, a great improvement in this direction.

The success of this metal for nitric acid plant has been great. Acid eggs, cocks, valves, pumps, and fittings, and even tantiron-lined steel pipes for high pressure are now used. Tantiron-lined pipes are claimed to wear one hundred times as long as the best pipes formerly used on the Rand for mine water and sand.

Messrs. J. Hopkinson & Co., Ltd., of Huddersfield, send their catalogue No. 700 of patent safety boiler

mountings and valves. This firm has specialised in the manufacture of these fittings for over seventy years, and now employs over 1,000 hands in their manufacture. Their special metal "Platnam," is nearly five times as hard as Admiralty bronze, and does not cut and score like many other alloys. The Hopkinson-Ferranti patent stop valve is claimed to mark a distinct advance in steam valves, some 15,000 being already in use.

Messrs. F. Leroy & Co., of Gray Street, London, E., specialise in coverings for steam and hot-water pipes. It is claimed that the saving effected is sufficient to cover the cost of lagging in from three to five months, a saving of over 80% in loss from condensation being obtained.

RONALD TRIST & CO., LTD., are increasing their capital to £20,000, and are equipping new works at Watford to cope with the increased demand for their products.

SHARE LIST.

Name of Company.	June 24th.	May 24th.
Alby United Carbide	1 1/2	1 1/2
Ditto. Pref.	1 3/4	1 3/4
Associated Portland Cement. (10)	5 3/8	5 1/2
Ditto. Pref. (10)	8 7/16	8 9/16
Babcock-Wilcox. Ord.	2 5/8	2 1/2
Ditto. Pref.	1 1/4	1 1/4
Bell's United Asbestos	1 9/16	1 1/2
Bleachers' Association. Ord. ..	1 1/2	1 1/2
Ditto. Pref.	1 3/4	1 3/4
Borax Consolidated. Pfd. (5) ..	5 1/2	5 1/2
Ditto. Defd.	1 1/2	1 1/2
Ditto. Pref. (10)	11 1/2	11 1/2
Bradford Dyers	1 1/2	1 1/2
Ditto. Pref.	1 1/2	1 1/2
British Oil and Cake. Ord. ..	1 1/2	1 1/2
Brunner Mond. Ord.	4 1/2	4 1/2
Ditto. 7% Pref. (10)	14 1/2	15
Bryant and May. Pref.	2 1/2	2 1/2
Calico Printers	1 1/2	1 1/2
Ditto. Pref.	1 1/2	1 1/2
Castner Kellner	2 1/2	2 1/2
Commercial Salt. (2/-)	6 1/2	7 1/2
Crossley & Sons. (2)	1 1/2	1 1/2
Ditto. 5% Pref.	4 1/2	4 1/2
Eastman Kodak. (\$100)	52 1/2	52 1/2
Eley Brothers	1 1/2	1 1/2
Fraser and Chalmers. (£3)	10 1/2	10 1/2
Gas Light and Coke. (S.)	10 1/2	10 1/2
Ditto. 4% Pref. (S)	9 1/2	9 1/2
Greenwich Lino. (1/2)	1 1/2	1 1/2
Harrison and Crossfield. Pref. ..	1 1/2	1 1/2
Imperial Continental. (S)	10 1/2	10 1/2
Ditto. 3 1/2% Debenture (S) ..	8 1/2	8 1/2
India Rubber Co. (10)	9 1/2	10 1/2
International Salt	3 1/2	4 1/2
Ditto. Pref. (5/6 pd.)	1 1/2	1 1/2
Lever Brothers. 1st Pref. (10) ..	11 1/2	11 1/2
Lister & Co. Ord.	1 1/2	1 1/2
Mappin & Webb. Ord.	1 1/2	1 1/2
Neuch'tel' Asphalt.	9 1/2	10
Nobel Dynamite. (10)	15 1/2	16 1/2
Ditto. Bearer (10)	10	10 1/2
Ditto. 5% Pref. (10)	11	12
Pears, A. and F. Ord.	1 1/2	1 1/2
Ditto. 6% Pref. (10)	12 1/2	12 1/2
Price's Candle. (16)	36 1/2	38 1/2
Rosario (5)	8 1/2	8 1/2
Salt Union. (4)	1 1/2	1 1/2
South Metropolitan 4% Stand-	10 1/2	10 1/2
dard (S)	10 1/2	10 1/2
Ditto. 3% Debenture (S)	7 1/2	7 1/2
United Alkali. (10)	1 1/2	1 1/2
Ditto. Pref. (10)	5 1/2	6 1/2
Val de Travers	1 1/2	1 1/2



THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY W. P. DREAPER, F.I.C.

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

VOL. III. No. 8.

AUGUST, 1914.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
" " Abroad 8s. " "

Position of the Chemist.

The articles published in this journal on this subject must have left many readers wondering at the great diversity of opinion expressed by the different writers. This is obviously due to the differences which exist in the profession, under which apparently two men of equal standing may be working under very varying conditions.

There is nothing strange in this, nor is this confined to the followers of chemistry. It is common to all professions. It may be more obvious in our case owing to the extremely varied and diverse nature of the chemist's work. Success undoubtedly depends upon other factors than that of the power to pass examinations. It entails a number of personal factors, and that vague condition which is termed opportunity.

Undoubtedly one of the general factors which have brought about the present position (whatever it may be) is the divided counsel which must follow from the multiplicity of societies or institutions covering the same ground. It may be that errors in the past have led to the presence of the Institute of Chemistry, the Society of Chemical Industry, and the Society of Public Analysts. On the other hand, their appearance may have been inevitable. The many interests involved may have been beyond the scope of a single society.

The effect of this division is seen in the clash between the different interests concerned, and the distinct line which still exists between those who are engaged in industrial work and those who teach.

Under the present conditions, there is undoubtedly great difficulty in dealing on general lines with matters of professional conduct, or the ways and means of exerting the full influence of chemistry on the general public. While the Chemical Society chiefly concerns itself with the work done in the colleges, the Institute of Chemistry is specially concerned with the question of the qualifications of professional chemists, in their relation to each other, and the public. The growing influence of the latter is undoubtedly one of the factors which counts, and only those who have attended its many council and committee meetings can form an idea of

its activity, or the work it is doing for the profession as a whole. The recognition it has received for its members by the Government departments is a direct sign of its advance. As Otto Hehner has pointed out, in this respect we are far ahead of any continental nation.

The want of some general control is probably most felt on the technical side, for this is "open" in a way which does not apply to teaching.

Light may be thrown on the conditions which exist in our profession by studying those which exist in the more highly and exclusively organised one of medicine. A present-day specialist in medicine is a man who for a time held a position in connection with one of the medical schools, during which some five hundred pupils (now local practitioners) passed through his hands. Having since set up as a consultant, he draws his present clients automatically from the recommendation of these past pupils.

Here we find conditions which have no satisfactory counterpart in the chemical profession, for the virtual divorce between teaching and college research on the one hand and the industrial side of our profession on the other is fairly marked, and in many cases almost complete. It may be that this is an important defect in our present system.

Certainly it is that, recognising the teacher, industrial chemist, and consulting man as the corresponding units to the divisions in the medical profession, the weak link in the chemical chain is the comparative absence of the section which in medicine receives the highest rate of remuneration.

To come nearer home, the same condition is found to apply to the engineering profession, as compared with that of the chemist.

If one considers the relationship which exists between the ordinary industrial chemist working in a works and the consultant, it will be at once seen that no such linking up exists. In fact one might say that a certain antagonism is rather present. It is not the rule for the works chemist when up against a problem to suggest that the consulting chemist should be called in. If such a course is taken, it is generally at the instance of the manufacturer and not at that of the investigator.

It may be suggested that this is not in the interests of the profession as a whole, nor of the works chemist in the long run, for it reduces his chance of becoming a consulting man and tends to keep him working in unnecessarily narrow grooves. The position of each unit in a profession must ultimately depend upon the general standing of his profession as a whole.

Again, at the present time there are undoubtedly a number of two- and three-year men trained in some technical college who call themselves chemists. In their way they may be admirable, and just the men for certain work; but in spite of all that can be done for them in such a short period the higher branches of chemistry must remain as a closed book, and they undoubtedly suffer (and also those who they serve) from the want of this closer touch with those consultants who may have this knowledge. From the medical point of view they must be regarded as equivalent of the ordinary practitioner working without the specialist behind him.

College Appointments.

The condition under which professors are almost entirely recruited from the college staff is apparently confined to our profession. This system, which Dr. Caspari has defined as "taking in each other's washing," must necessarily leave the universities out of touch with industrial conditions. One of the reasons why the industrial man is considered unfit to occupy a chair in a university is possibly due to the fact that the teaching programme in the university has been moulded into a common type by those who in the past have only had a college experience to work on, and, consequently, the man with an industrial experience finds it difficult to serve under conditions where what one might call for the purpose of identification "Chemical Society" chemistry alone is considered. The medical student comes in contact with the specialist in the hospitals. Ours is the only profession where knowledge gained by actual experience is classed of a lower order.

In passing, it may be interesting to observe that the recently offered post of Professor of Chemistry at the Heriot Watt College has been advertised as being specially open to an "applicant who has had both teaching and industrial experience." It will be interesting to watch the result of this appointment.

The question may be fairly asked, Can anything further be done to improve the chemist's position in the eyes of the general public, and is the general position unnecessarily weak when compared with that of other professions? This question can only be dealt with when the profession as a whole decides to tackle it. If this matter is to be shelved until one of the present societies or institutions obtains an undoubted ascendancy over all others, and can dictate terms, the profession as a whole will suffer, and be subject to internal dissension in the meantime.

It may, therefore, be reasonable to regard the very divergent views expressed in the articles referred to as a symptom of an internal condition which is capable of modification.

SOCIETY OF CHEMICAL INDUSTRY.

Annual General Meeting.

This was held at Nottingham, on July 16—17th, with the usual success which accompanies these meetings. At the general meeting itself the Society's medal was presented to the Right Hon. Sir Henry E. Roscoe, LL.D., F.R.S. Many works were visited on the 16th, which finished up by the annual dinner at the Exchange Hall. The 17th was devoted to a whole day excursion to the Dukeries.

In the report of the Council the membership is given at 4,142. Dr. Messel, who represents the Council on the governing body of the Imperial College of Science and Technology, has been instrumental in securing the establishment of full professorships in organic and physical chemistry. The Council, through him, also support the complete independence of the college. The next annual meeting will be held in Manchester in September, 1915, when the British Association also meets there at the same time. The Council are considering the question of holding conferences on important matters at the annual meetings, and a committee has been appointed to consider means for increasing the membership and usefulness of the Society.

The concluding words of Sir William Crookes' address may be quoted:—

"We may be certain that discoveries of vast importance are waiting their Newtons. Secrets of nature are lying hidden ready to disclose themselves to the 'immortal mind.' But is not the attitude of the public towards investigators lacking in understanding and imagination, and do not the authorities treat scientific exploration in a niggardly spirit? Scientific men have to deplore the fact that there appears to be a lack of men gifted with the genius for research and for grappling with the riddles of the earth. Scientific research has been and is being starved. It is high time measures should be taken to remedy this state of affairs, which otherwise can only end disastrously for the nation. I do not wish to come before you as an alarmist, but rather as one who can diagnose the disease and suggest the remedy. I know you will be in hearty and enthusiastic agreement with me when I say that the allotment of public moneys to the furtherance of scientific work, the tangible recognition of the services of scientific men, the provision of opportunities for all kinds of investigations of scientific problems without reference to their immediate commercial value—these are the benefits we look for at the hands of Government and of the nation. And what are our responsibilities and duties in regard to research? I think our chief care should be to see that we encourage and cultivate the right type of man for research work. We should make more definite efforts to select suitable men from among our students and to train them to the highest point of efficiency, after having made up our minds what are the special qualities we need. I think we can learn a great deal from the training of our army scouts. Our researchers are actually scouts, penetrating strange and unknown countries, and the keys to success are the same as for all scouts. The principal qualifications are confidence, keenness, intrepidity, inspiration. The knowledge that you are well equipped for your work, the belief that your training has been thorough, and that you have made the best possible use of it, should develop in you the self-reliance and boldness indispensable in a scientific scout; other valuable qualities, quickness of eye and mind, and the power of reasoning and expression, can undoubtedly be developed and perfected."

M. V. LOMONOSOV—AN EARLY RUSSIAN CHEMIST.

By DR. A. J. ALLMAND, Liverpool University.

THE subject of this short paper was one of the most remarkable and strenuous figures in Russia in the middle of the eighteenth century. He has long been regarded as the founder of modern Russian literature. His work in that field was essentially of a pioneering character, and therein lay its chief merit. Otherwise it was not particularly inspired. But only in very recent years has it been discovered that his achievements in science, especially in chemistry, were of a very different nature, and, indeed, were such as to entitle him to an honourable position on the roll of the world's famous chemists. The credit of discovering Lomonosov's papers in the archives of the Russian Imperial Academy of Sciences, and of editing and publishing them for the first time about two years ago, is due to Professor B. N. Menshutkin. We also owe to him several monographs on Lomonosov, from one of which the illustrations and many of the facts contained in this sketch are taken. A selection of Lomonosov's papers was published in Ostwald's *Klassiker* (No. 178) in 1910, and Professor Alexander Smith devoted to him his presidential address before the American Chemical Society a few years back. The present paper is an attempt to make Lomonosov known to a somewhat wider circle of English readers.

Mikhailo Vasilivich Lomonosov was born in 1711 near the shores of the White Sea, not far from the town of Kholmogory, in the government of Archangel. His father was a wealthy and influential member of a peasant community, which still occupies itself with fishing and trading, in some cases voyaging as far as Scotland. Lomonosov's early youth, except in that his father's circumstances enabled him to learn to read and write when quite young, did not differ from that of other boys of similar birth. He accompanied his father on trading and fishing expeditions, and suffered all the hardships incident to such a life. The icebergs and strange northern lights, the tempests and snowstorms experienced on the wild seas he sailed, all made an abiding impression on him. Besides firing his imagination, they also developed his faculties of observation and deduction, and distinctly influenced his later work.

Lomonosov, however, craved for something more than the hard life of his forefathers. Further school education was denied to him as a peasant, and he had to do the best he could by private reading.

Apart from religion and theology, the only books obtainable were a grammar and an arithmetic. These he borrowed and studied unceasingly, and, finally, begged from their owner. Gradually, nevertheless, he grew less and less contented with his lot. His father was disappointed in him, and the advent of a stepmother who took a dislike to him made his position at home intolerable. Secretly obtaining

a passport, he set out with a few borrowed roubles and a load of fish for Moscow. He was then nineteen years of age. Here for some years he lived in great poverty, studying first at a school, later at the Moscow Academy, and for a short time in 1733 at a theological academy in Kiev, from which he returned thoroughly disillusioned by the exclusive diet of Aristotelian philosophy given him there, and with any ideas of ordination finally banished. During these years Latin and theology were the chief subjects in which he was instructed. For science he had to depend on his own private reading.

But in 1735 his chance came. The Academy of Sciences in St. Petersburg, founded in 1720 by Peter the Great, inquired of the Moscow Academy as to whether they had any students who were worthy to be sent to Western Europe for further study. Lomonosov was recommended. He at



M. V. LOMONOSOV.

once went to St. Petersburg, and, after spending a few preparatory months in the gymnasium attached to the Academy, proceeded abroad to study chemistry and metallurgy. He first directed his steps to Marburg, where he remained for three years, during which time he more particularly came under the influence of the famous Professor Christian Wolff, mathematician and physicist, and an honorary member of the Russian Academy. He then proceeded to Freiberg, to work in the renowned School of Mines. Here he was less fortunate in his teachers, who, although excellent instructors in the practical work of metallurgy, did not possess the freshness and breadth of outlook on theoretical matters which had characterised the men under whom he had studied at Marburg. With one of them, Henkel, he quarrelled. At the end of a year's wandering in Germany and the Low Countries, marked by much poverty and by several adventures, he returned to Marburg. Here he married, and shortly afterwards, in 1741, returned to St. Petersburg. The Academy gave him a position as adjunct in the Department of Physics, and paid the debts

which he had accumulated abroad. His salary, in addition to lodgings and other allowances, would come to about £200 of our money. Unfortunately, the financial condition of the Academy was the cause of this salary being largely paid in the form of the Academy's publications.

The next year his position improved. He began to lecture on the Russian language (in Latin!), on physical geography, and on chemistry. His experimental career as a chemist may be said to have commenced in 1744, and in 1745, as the result of his dissertation, *De tincturis metallorum*, he was appointed by the Academy to the Chair of Chemistry. This he held till 1757, during which time, particularly after 1748, when a laboratory with which the Academy provided him was completed, his best work was done. Subsequent years were spent in theoretical work, writing and translating textbooks, literary labours, and in multifarious activities connected with the Academy. He devoted much time to the administration of the different teaching institutions connected with it, and was one of the founders of the University of Moscow. Influenced by his youthful experiences, he paid much attention to the investigation of problems connected with oceanography and with the sea generally. He prepared the plans for expeditions which investigated the sea to the north of Siberia, and directed the surveying and mapping of certain parts of Russia. He studied questions of atmospheric electricity, including the Northern Lights, of whose real nature he had a very good idea. One of the first subjects he took up after 1748 in his new laboratory was the working out of the technique of preparing different kinds of coloured glass. From this he and his pupils fashioned in 1752 the first mosaic pictures made in Russia. In recognition of this, the Empress Elizabeth Petrovna presented him with an estate in the neighbourhood of St. Petersburg, and on this estate he founded a glass factory which is still in existence. Astronomy also claimed much of his time, and on May 26th, 1761, when making observations of the passage of Venus before the sun's disc, he discovered that planet to have an atmosphere "as great as, or perhaps greater than, that of the earth." This is the important discovery which is commonly attributed to the astronomers Schröter and Herschel (1791). His literary work comprised the first Russian poems written in modern verse form, tragedies, the first Russian grammar and the first Russian treatise on *Style*, and, finally, philological and historical studies. These different activities occupied him to the end of his life. He died after a long illness in 1765.

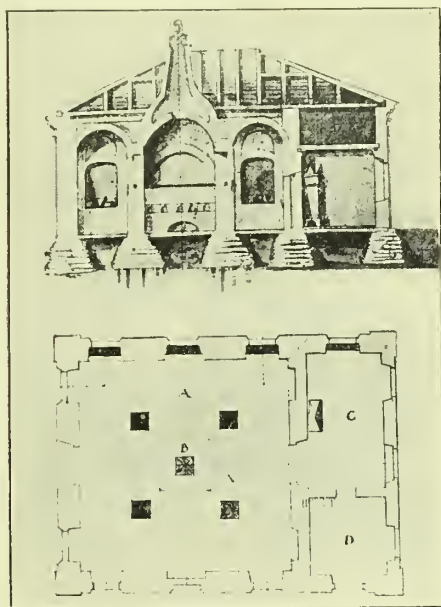
To appreciate fully the outstanding nature of Lomonosov's outlook on chemistry, we must remember that he worked when Stahl's phlogiston theory of combustion was at the height of its influence, being accepted by nearly every chemist of note in Europe. There is no need to discuss this famous theory here. Suffice it to say that systematic quantitative experiments, such as were carried out by John Mayow, would soon have disposed of it. But they were not made, and the few isolated

results which were obtained and published, and which directly contradicted Stahl's views, were explained away by the wildest *ad hoc* assumptions. The topsy-turvy state of affairs which prevailed with regard to the all-important question of the explanation of combustion unfortunately communicated itself to other matters. For example, salt, sulphur, and mercury were still supposed to be the three elementary principles, whilst heat, light, and even weight were regarded by many as being forms of matter. And, again, the utmost confusion existed with regard to the fundamental distinction between *properties* and *magnitudes*. Such was the state of chemical science in Lomonosov's day, and such were the tenets held by most of his own teachers.

Lomonosov differed from the great majority of his contemporaries in two very fundamental and related ways. He frankly regarded mathematics, and not speculative hypotheses, as providing the ultimate theoretical basis of all physical and chemical science, and, like Boyle, he insisted throughout on the importance of vigorously testing every assumption by means of appropriate experiments, which, moreover, must be quantitative, not merely qualitative. Mathematics he likens to the eyes, chemical experimental technique to the hands, of physico-chemical science—only by the co-ordinated use of both can the goal aimed at be achieved. All chemical and physical changes involve the motion of certain particles, though these motions are often imperceptible to the unaided senses. The phenomena of motion are governed by the laws of mechanics, and for their understanding mathematics is necessary. In his incomplete *Elementa Chymiae Mathematicae* (1741) he develops his ideas on these questions, and draws out a programme of quantitative experimental work for investigating the relations existing between chemistry and mathematics. The laboratory built for him in 1748 after many delays, at a cost of 1,344 roubles, enabled him to embark on this programme. As we can see from the interesting architect's plan which is here reproduced, it was a modest building of one storey, measuring some 35 by 45 ft., and contained three fairly lofty rooms. Of these the largest was the actual laboratory, C and D being used as lecture room and store room respectively. The middle of the laboratory was occupied by a large stove provided with a big domed hood and flue for the removal of fumes. Under the hood stood a number of small charcoal-fired furnaces for heating purposes. Besides furniture such as tables, cupboards, and benches, the laboratory also contained instruments and stocks of glass apparatus and of chemicals. A prominent feature of the plan is the stove in the store room, whilst the main laboratory is shown embellished with what the architect presumably regards as chemical apparatus. Fittings and apparatus brought the total cost of the laboratory up to 2,000 roubles, corresponding to about £1,000—£1,200 of our current money. In 1749, a laboratory man was engaged, "accustomed to deal with fire." In this building Lomonosov and his pupils

carried out a large amount of experimental work, of which, unfortunately, only very incomplete records have come down to us. The point to be insisted on at this juncture is the explicitly quantitative nature of all the experiments, a distinction which marks out the work of Lomonosov and his pupils from that of nearly all his contemporaries.

Directed in his work, theoretical and experimental, by these two guiding principles, endowed, moreover, with a singularly clear and critical mind, Lomonosov arrived at a number of results and conclusions on matters of the most fundamental nature in physics and chemistry in which he anticipated, in some cases by very many years, those scientists to whom the first statements of these conclusions and results are still commonly ascribed. Some of his views we will very briefly discuss. In



LOMONOSOV'S LABORATORY.

the first place his writings are free from the then current confusion which existed with regard to "qualities" and "quantities." He distinguished carefully and explicitly between the properties of a body and the different magnitudes which can be quantitatively measured in connection with that body, and opposed the conception of heat, light, weight, etc., as forms of matter. He was of opinion that heat was a mode of motion, a view not generally accepted till well on into the nineteenth century, and was aware that this view involved the existence of a lower limit to temperature ("absolute zero"), though not an upper one. He distinguished between the heat content of a body and radiant heat, ascribing the latter to a wave motion in the "ether," his idea of which was very similar to the conception so much used in modern physics. Light he also regarded as wave motion in the ether (he was throughout an opponent of the Newtonian corpuscular theory) and sound as wave motion transmitted by the air particles. His ideas on combus-

tion were directly opposed to those current at the time. He was of the opinion, stated very definitely, that instead of phlogiston being lost when a metal is calcined, particles from the air are taken up by the metal and combine with it, giving the oxide. To test this, he repeated in 1756 some experiments of Boyle, who had heated lead and tin in sealed glass retorts containing air, and who had ascribed the increase in weight experienced by the metals to the absorption of "fire particles" which had passed through the walls of the retort. Lomonosov showed that if the whole retort with its contents were re-weighed before opening, no change in weight could be observed, proving that the increase in weight of the metal must have come from something already present in the retort before sealing up, that is from air particles. In these experiments he anticipated Lavoisier by eighteen years. He fully recognised the principles of the conservation of matter and of energy, and regarded matter as having only a limited divisibility. He distinguished between atomic and molecular compounds, and indicated the possibility of isomerism. In his *Tentamen theoriæ de vi æris elastica* he developed the views of Bernouilli, the Russian Academician, into a very fair anticipation of our modern kinetic theory of gases, first generally accepted a century later as the result of the work of Clausius and of Krönig. In particular he predicted that at high pressures Boyle's Gas Law would be found not to hold, and furnished the correct explanation for the deviations which were actually discovered later.

The above paragraph will suffice to show to what extent Lomonosov was ahead of his contemporaries on matters which are to-day generally regarded as the very classics of the chemical and physical sciences. Still more striking, perhaps, is another aspect of his work—his anticipation of that comparatively new branch of chemical science known as physical chemistry. We cannot do better than define physical chemistry as Lomonosov did—as "a science which explains, by means of physical laws and physical experiments, the changes which occur in chemical compounds during chemical operations." It is a science the basis of which is mathematics and the experimental part essentially and necessarily quantitative, and we have already emphasised the views of Lomonosov on these points. Space forbids us to elaborate further this aspect of his work. Suffice it to say that the programme of experimental research which he drew up was extraordinarily comprehensive, and would by no means disgrace a modern laboratory. For example, it included measurements of solubility, density, volume and thermal changes, boiling-point, freezing-point, rate of solution, rate of cooling, cohesion, refractivity, surface tension, colour and the action of electric forces, the measurements being made on water and solutions in it of different substances. Many other investigations were also schemed out. We know that a large number of experimental determinations were actually made in his laboratory. Unfortunately, the greater number of the laboratory journals have not yet been discovered, and tables

of results are the chief data available for the appraisal of his work. These suffice to show us that, though in some cases the methods used were obviously very approximate, yet nevertheless certain important facts were discovered—notably, some connected with the freezing-points of aqueous salt solutions.

Why is it that Lomonosov's work was so completely without influence on the subsequent development of the science, and in fact, remained for long in utter oblivion? We must agree with Professor Menshutkin that several causes were contributory. Many of his publications were only fragmentary, and much of his most important work remained unpublished. It has been suggested that Lomonosov's reason for this was to avoid the bitter personal controversies which would be bound to arise, and in some cases did so, as the result of the publication of views running entirely counter to those at that time accepted by the majority of chemists. It should be mentioned that in two of his less important writings, one presented to the

Russian Academy when applying for his professorship, and the other to the Prussian Academy when competing for a prize offered by that body, Lomonosov suppressed his own views on phlogiston and combustion, and adopted the, at the time, usual and conventional terminology. Another reason is perhaps that many of his ideas were too far ahead of their times. Most important of all, however, were his other manifold activities, by means of which his attention was constantly being distracted from what would otherwise have been undoubtedly, in every sense, his most fruitful field of work. Lomonosov was himself under no delusions as to the negligible effect he had produced on his contemporaries. Almost his last words were the following: "I view the approach of death with indifference; and only regret that I have not been able to bring to completion all that I have undertaken for the good of my country, for the development of science, and for the honour of the Academy. Here at the end of my days I am compelled to recognise that all my fruitful ideas will die with me."

SOME ORGANIC CONSTITUENTS OF SOILS.

By C. T. GIMINGHAM, F.I.C.

A GREAT deal of work has been done in recent years, and is in progress at the present time, upon the organic matter of soils. Nevertheless, owing to the complexity and variable character of this organic material, we are still far from having any very definite conception of its general nature. The dark brown substance known as humus which can be extracted from soils by alkalis, and which consists mainly of partially decomposed plant residues is, it is true, of fairly constant composition, containing about 50% of carbon and from 4 to 6% of nitrogen: but of its real chemical nature little is known. The old view was that, in soils giving an acid reaction, the humus consisted of certain ill-defined acids termed humic, ulmic, crenic and apocrenic acids, whilst in neutral soils their place was taken by the calcium salts of these acids. It is now held by some investigators that the humus of soils does not really contain acids at all, and that the apparent acid reactions given in many cases are to be explained as adsorptive effects due to the soil colloids. This matter is still controversial: but we do now know something more definite with regard to the chemical nature of some of the substances which make up the soil organic matter.

In America, Whitney and Cameron, of the Washington Bureau of Soils, have put forward their hypothesis that the differing fertilities often to be found between two soils of the same type are due to the presence or absence of substances with injurious effects upon plant life (toxins). It is hoped to discuss their theories, which are open to criticism in many directions, in a future article; but we may refer here to the papers of Schreiner and his co-workers who, in the search for such toxins, have isolated a number of interesting organic compounds from various soils.

In the earlier work (*Bull. No. 53, Bureau of Soils*) four compounds were identified: dihydroxystearic acid, $C_{18}H_{36}O_4$; picoline carboxylic acid, $C_7H_7O_2N$; agroceric acid, $C_{21}H_{42}O_3$; and agosterol, $C_{26}H_{44}O.H_2O$. The method of treatment was to extract the soil for a short time at room temperature with 2% alkali. The resulting alkaline extract was then acidified, causing the formation of a precipitate ("humic acid"); both precipitate and acid filtrate were then examined. The two former compounds were obtained from the filtrate, the dihydroxystearic acid by shaking out with ether, and the picoline carboxylic acid by precipitation in neutral solution with silver nitrate. Dihydroxystearic acid is unknown as a natural product and is presumably formed in the soil by bacterial or fungal action. It is specially interesting since it appears that this acid can almost invariably be found to be present in infertile soils in larger quantity than in fertile soils (Schreiner and Lathrop, *J. Amer. Chem. Soc.*, 33, 1412; Schreiner and Skinner, *Bull. 70, Bureau of Soils*). It appears to have a bad effect upon the growth of wheat plants in water culture; and an important rôle is assigned to it in determining fertility.

One of the mono-hydroxystearic acids— $CH_3(CH_2)_6CHOH(CH_2)_9COOH$ —has also been obtained from soil (*Bull. 74, Bureau of Soils*) in the alcoholic extract of the humus precipitate. After a somewhat lengthy process of separation, this substance was found to come down from an alcoholic solution, on cooling, as "a white or yellowish microcrystalline powder." The crystals melt at $84-85^\circ C.$, and the elementary analysis corresponds with the figures calculated for $C_{18}H_{36}O_3$. Other substances separated from this alcoholic extract are certain liquid glycerides, resin acids and esters, and paraffinic

acid, a body apparently identical with the substance obtained by Pouchet (*Bull. Soc. Chim.* 23, 111) by the action of fuming nitric acid upon paraffin.

Another set of substances was obtained by extracting soil direct with boiling 95% alcohol instead of dilute alkali. A hydrocarbon—hentriacontane, $C_{31}H_{64}$ —phytosterol, agosterol, agocerol and lignoceric acids were separated in this way. Lignoceric acid has an elementary composition $C_{24}H_{48}O_2$, a melting point at $80-81^\circ C.$, and is obtained by purifying the precipitate which separates when the hot alcoholic extract is allowed to cool. The same substance was isolated from the "dark-coloured tarry distillate" obtained by heating a peaty soil in a closed tube.

Many interesting *nitrogenous* compounds have also been found by these investigators in addition to the picoline carboxylic acid already mentioned. The liquid obtained by the acidification of the alkaline soil extract and removal of the precipitate has been found to yield cytosine, histidine and arginine (precipitated by silver nitrate in alkaline solution), and also xanthine and hypo-xanthine (precipitated by copper sulphate in alkaline solution).

Later work (Schreiner and Skinner, *Bull.* 87) has shown also the presence of guanine and adenine; and experiments are cited in this later bulletin going to show that such substances as histidine, creatinine and asparagine are utilisable by plants as such without conversion into nitrites or nitrates.

It is not suggested by Schreiner that all these substances occur in any one soil, or that those mentioned by any means exhaust the number present. The substances of which the soil organic matter is composed may be any of the innumerable compounds, manufactured by plants and animals, which have succeeded in resisting decay and, in addition, any of the decomposition products to which these may give rise; and, indeed, the consideration of this long list of compounds, belonging to so many different types, which have been isolated, serves to emphasise the extreme complexity of "humus" and the need for increased and more thorough investigation. At the same time, according to Schreiner and Shorey, "the complexity is not so great that the chemical nature of all of the organic matter of soils cannot be determined by modern methods of research."

CHEMICAL INDUSTRIES.

A Monthly Review of the Progress of Technical Chemistry.

THE STERILISATION OF WATER BY MEANS OF LIGHT.

By DRS. S. AND E. RIDEAL.

THE beneficial effects of sunlight on water were noticed at a very early date. As early as 1640 Dr. Hart cautioned his readers against the use of well-water "to which the sun hath no reflection." While the growth of green algæ can be prevented by excluding light from water during storage, yet the beneficial effect of light in destroying the germs of disease is in this way hindered or lost. The algæ may become troublesome, but are not dangerous like the pathogenic bacteria, and as the former undoubtedly cause a disappearance of some of the organic matter present, when not superabundant or of objectionable species conferring odours or tastes, they are actually useful.

The germicidal power of sunlight is strongest beyond the visible spectrum in the ultra violet, while ordinary daylight and most forms of artificial illumination, so far from retarding growths will often assist them.

Downes and Blunt (*Proc. Roy. Soc.*, 1877, 26, 188), were the first to systematically investigate the sterilising action of light on contaminated water. They found direct sunlight speedily fatal to most bacteria, and even in a little longer time to spores, while diffused light is harmful in a less degree. Dieudonné (*Arch. Kais. Gesund.*, 1894, 405), showed that the germicidal power of the light increased as it progressed from the red to the ultra violet.

Westbrook, at Marburg in 1900, showed that the action was not simply a physical one, but depended greatly on the function of the chemical rays in promoting oxidation;

therefore free access of air is necessary. Observers have found that the inhibitive property of direct sunlight may penetrate in clear water to 6 or 8 ft., but with any turbidity it is soon arrested. Buchner's (*Arch. f. Hyg.*, 1893, 17, 179) results with *Vibrio cholerae*, *B. typhi* and *B. pyocyaneus*, were that light is germicidal down to 1.6 metres (5 ft.), but that its antagonistic effect on some bacteria in clear water did not become imperceptible till a depth of three metres (9.8 ft.) was reached. Whipple (*Internat. Congr. App. Chem.*, N.Y., 1912), remarks that disinfection by sunlight is not a factor at depths greater than a few feet, although in the Tropics the effect may be more marked and even become of importance (Clemesha, "Bacteriology of Surface Waters in the Tropics," 1912).

The earliest scientific study of the biological effects of ultra-violet light was by Finsen and his pupils, who applied the bactericidal effect of the rays, produced artificially, to the curing of lupus and other fungoid diseases. The germicidal power of light in general and of ultra violet light in particular, having been proved, the next point was, as always, economical generation and use.

Ordinary gas burners, incandescent mantles or glowing filaments are very poor in such radiations, but, on the other hand, incandescent vapours are frequently rich in this actinic light, especially those of iron, aluminium, and mercury. Early experiments were carried out with electrodes of iron, or iron with aluminium cores, for the production of an electric arc between the ends. The water was allowed to run in a thin film exposed to the rays, but the time of exposure to the light was generally not sufficient and difficulties occurred in the removal of the oxides of iron or aluminium formed. At Neuilly-sur-Marne a lamp of

this type has sterilised a cubic metre of water with a current consumption of only 20 watts.

Leo Arons (*Wied. Ann.*, 1892, 47, 767) was the first to make successful use of glowing mercury as a source of light. In 1895, M. Chas Lambert submitted to the Paris Service des Eaux, the description of a process for "subjecting water to an intense illumination, while opposing no obstacle to the ultra violet rays of the spectrum," and later M. de Mare patented "the use of quartz lamps with mercury vapour for sterilising potable liquids such as water."

In 1909 Drs. Courmont and Nogier communicated to the Academy their research on the subject, which was followed by many others proving that the pathogenic and other organisms were destroyed by short exposure, not connected with ozone formation, as has been supposed; but the water had to be specially freed from suspended matter since particles screened the microbes from the irradiation. It is because ordinary glass, though transparent, absorbs a great part of the rays, that the lamps are constructed of fused silica. To utilise all the available light, the lamps are frequently entirely immersed in the water to be sterilised and in many cases they are protected by a thin transparent envelope, which of course involves a small air space and some absorption of the rays. With immersed lamps two difficulties occur: in the first place, after a while the lamp becomes covered with a scale of deposited earthy carbonates and iron, blocking out the rays; secondly, the temperature is considerably lowered by the immersion, and the light emission for a given watt consumption seriously reduced. Consequently the lamp is often placed directly above the water, although this involves a sacrifice of energy. Dr. Recklinghausen remarks, "In such a system and in spite of reflectors, only perhaps 30% or 40% of the light emitted entered the water and obtained its effect."

The use of baffle plates make the water pass several times under the influence of the rays, thus lengthening the period of exposure. The action is very little affected by the temperature of the water; even ice, if transparent, can be sterilised in about the same time as water.

As has already been mentioned, the action is not dependent on the production of ozone, and is not dependent on the amount of dissolved oxygen in the water; only minute traces of hydrogen peroxide are formed after several hours, whereas the sterilisation takes only a short exposure.

Various classes of organisms are not all equally sensitive to the rays, just as they are not equally sensitive to heat or to chemical agents, subtilis and tetanus being the most resistant of those tested.

The following table, from tests carried out in the Sorbonne University, illustrates the effective range of the rays in an ordinary water infected with *B. coli* but free from colour and suspended matter.

Distance from lamp.			Number of seconds required to sterilise with a 220 volt lamp.		
10 cms.	..	..	..	..	1
20 "	..	..	..	..	4
40 "	..	..	..	..	15
60 "	..	..	..	..	30

It will be noted from these figures that the time of sterilisation does not follow the "law of the inverse square of the distance" with any great degree of accuracy. This rather surprising result has been confirmed quite recently by some careful experiments by R. Scharff, at Massachusetts, who came to the conclusion that no such

generalisation was to be found between distance and sterilising power.

There is at the present time no satisfactory explanation to account for the germicidal power of actinic light. Ultra violet light not only increases the velocity of many simple chemical reactions, but at the same time it is very effective in bringing about complicated polymerisation of unsaturated compounds, so that it appears likely that the action is one of removal or destruction of some important compound, e.g., an enzyme necessary for the life of the organism, and does not directly cause the environment of the microbe to become unsuitable for its existence. Some recent investigations seem to indicate that a gradual change and modification in the characteristics of any particular organism may be brought about by gentle and continuous irradiation. If these are confirmed our knowledge on the factors concerning the origin of species, at any rate as far as micro-organisms are concerned, will be greatly extended.

However, apart from the explanation, the facts justify the use of ultra violet light as a valuable adjunct to our means of providing pure and wholesome water to the community.

THE VISCOSITY OF RUBBER SOLUTIONS.

By CLAYTON BEADLE and HENRY P. STEVENS.

SINCE the appearance of Axelrod's original paper on this subject a number of chemists have published work dealing with the viscosity of rubber solutions, without, however, throwing very much light on the matter. In one or two instances the results of experiments have been published, which seem to accord very well with the view that the quality of the rubber varied with the viscosity of the solution—the greater the viscosity, the higher the quality of the rubber. In such cases, however, the samples chosen for the experiments were of similar type and similar make, and further work by ourselves and others has clearly shown that viscosity is a very doubtful guide to the quality of rubber.

Before proceeding further, it may be as well to refer to a question of nomenclature frequently raised when dealing with viscosity tests, and which is met with, not only in connection with rubber solutions, but with oils and other similar substances. We refer to the distinction between "viscosity" and "rate of efflux." Schidrowitz, who published work on the viscosity of rubber solutions, holds that Axelrod's figures do not represent viscosity figures at all, but merely rate of efflux. This is no doubt perfectly true, but the rate of efflux is almost entirely dependent on the viscosity, so that, if it is found easier to determine the rate of efflux than the viscosity, it will be better to determine the former. We are dealing with viscosity of rubber solutions, not from the point of view of an investigation into the nature of viscosity, but as a practical means for determining quality. What is required is some test—call it viscosity or rate of efflux, or what you will—which will enable an estimate to be made of the quality of the rubber by a shorter and more expeditious process than that of vulcanisation. Even supposing that the results obtained in such a test were approximately accurate, they would be of considerable value. As it is, it may almost be said that we have no indication of the quality of a rubber until we have vulcanised it and examined the vulcanised product. Further, vulcanisation is not the simple process many imagine it to be, nor is the state of the rubber when vulcanised a stable one,

Changes go on from the moment vulcanisation is complete, even when curing has been rightly adjusted. These changes are particularly rapid during the first few days, and physical tests on samples two or three weeks old give appreciably different figures from those obtained on testing the day following vulcanisation. Further, vulcanisation can be carried out in a great variety of ways, and the effect on the rubber is in each case a different one. Hence a vulcanisation process is one extremely difficult to standardise. These remarks will illustrate the demand there is for some simple and rapid test which would give an approximate idea as to the relative value of different samples of raw rubbers.

Axelrod was essentially practical in his views through constant association with manufacturing operations. Hence he sought a process which was rapidly and easily applied. His system has been further studied by Franck and Marckwald, who have designed a special apparatus in which the test can be made. On the other hand, Schidrowitz and other observers have employed the Ostwald viscometer, working with solutions more dilute than those employed by Axelrod.

Crude rubber consists of other substances besides the caoutchouc hydrocarbon, and recent work of our own and of Weber in America has illustrated the importance of at least two of these constituents, namely, the protein and the resin, as affecting the quality of the rubber. In viscosity determinations it is the aim to remove the protein as completely as possible before making the determination. Consequently, any effect on quality due to the nature and proportion of the protein cannot be revealed in the figure for viscosity of the solution used. As regards the resins, these, in solution, have relatively low viscosities, and would be without very marked effect on the final figures obtained. Consequently, as far as the resins are concerned, the tendency would be somewhat to reduce the viscosity of the solution.

We have ourselves published some work in which various proportions of resins were added to a solution of rubber in benzene, and viscosity determinations made with the Ostwald viscometer. The effect of the addition of resins to the solutions was quite distinct but not very great.

As regards the protein, this is in many cases very difficult to remove from the solution before making the viscosity determination. In the case of *crêpe* rubbers the treatment on the rollers has so disintegrated the protein matter that the greater part remains in suspension on dissolving the rubber in benzene. This suspended matter takes many weeks to settle, and it would be quite impracticable to wait for this to take place. Consequently, the tests must be made on the benzene solution containing the finely divided protein matter in suspension. This would be a disturbing factor, although its effect is not likely to be very great.

In the case of sheet rubber, fine hard Para, and similar products, which have not been put through a differentially geared roller machine, the protein matter is not disintegrated but holds together, forming a skeleton framework containing the rubber. On immersion in the solvent the rubber swells, and gradually passes out into the surrounding fluid. The complete removal of the rubber is, however, a tedious process, requiring frequent treatments with fresh portions of the solvent. About half of the caoutchouc is relatively easily removed, but how far may this portion be regarded as identical with that which remains still enclosed in the protein framework? We have made experiments with a view to testing this matter, but the results are complicated by the fact that the first treatment with benzene removes

practically the whole of the resin, and this resin also affects the viscosity of the solution. Moreover, solutions when once prepared are very sensitive as regards their viscosity. Keeping almost invariably lowers the viscosities, as also does change of temperature. Experiments are, therefore, beset with difficulties. Caspari has recently published some work in which he claims to have fractionally separated the caoutchouc by using petroleum ether as a solvent. According to his results, there is a very marked difference—one might almost say a great contrast—between the portion of the caoutchouc which is readily removed and that which is insoluble, or more difficultly soluble, in the petroleum ether. It would appear that the part easily removed gives a solution of much lower viscosity and, if this is the case, it may be very misleading to determine the viscosity of a portion only of the rubber as extracted by the solvent. It is probable that, if a fractional separation can be effected based on a difference in solubility of the rubber in petroleum ether, a similar separation, if a less complete one, would be affected by benzene or other similar solvent.

We have stated that the viscosity of a rubber solution generally falls when the solution is kept or heated. This is of minor importance as regards testing, seeing that there is no need to heat the solution, and the tests can be made at agreed intervals. Beyond introducing complications, the sensitive nature of the solution alone does not condemn viscosity or rate of efflux as a practical test. Unfortunately the viscosity of the solution when prepared is enormously influenced by the mechanical treatment to which the rubber has been subjected beforehand, that is, to its previous history. From the beginning of the manufacturing industry it has been a matter of common knowledge that the degree of mastication determines the viscosity of the solution when prepared. It is quite an easy matter so to treat a rubber on the mixing rolls that the solution when prepared appears hardly more viscous than the solvent, while the rubber before treatment produces a solution so viscous that it will hardly flow at all. The principle has been employed in the manufacture of solution or dough for waterproofing and other purposes from the time of Macintosh to the present day. Consequently, when interpreting the viscosity figures, the previous treatment of the rubber must be allowed for. Unfortunately, samples of rubber submitted for examination are not accompanied by a label giving the exact methods of preparation. We can only tell whether the rubber has been put through the washing machine or not. In either case we are ignorant of the extent of the mechanical treatment. Our knowledge is limited to the fact that the unwashed rubber has almost certainly been handled to a lesser extent than the washed. The latter will be in "*crêpe*" form, but we cannot say how many times it has been rolled; we do not even know whether it has been dried in the original *crêpe* form or subsequently *re-crêped* when dry. Much of this treatment will reduce the viscosity, a single passage through the rollers will have quite a considerable effect, but it cannot be held to damage the rubber, for it only anticipates a fraction of the treatment to which the manufacturer will subsequently put it. Nevertheless, it lowers the viscosity and impairs the value of such a measurement as a test for quality.

To put this matter thoroughly to the test we carried out a series of experiments in which viscosity determinations were made side by side with tests on the vulcanised rubbers. A representative series of rubber samples was chosen, including smoked sheets and pale *crêpe* rubbers as well as fine hard Para. The viscosity determinations were made on very dilute solutions by means of the Ostwald viscometer,

and at the same time experiments were made with the rate of efflux apparatus on the lines of Axelrod. The results showed that, although in one or two cases the best samples gave relatively high viscosity figures, there were very numerous exceptions, and, had the determinations either of viscosity or rate of efflux been taken as a guide to quality, the results would have been very misleading. All the samples tested were Para rubbers. Had the series been extended to rubbers of other botanical origin, needless to say, further complications would have been introduced and the results even less concordant than they actually were.

PERSONAL AND OTHER NOTES.

THE City of London University College Endowment Fund Committee has issued an appeal to the public for a sum of £30,000, part of which is needed to equip the new chemical laboratories.

The late Miss Ida Freund, Lecturer in Chemistry at Newnham College, Cambridge, has left £17,494. The residue of her estate, amounting to about £8,000, is left to the Woman's University Settlement at Southwark, S.E.

In connection with the International Exhibition at Ghent in 1913, M. Barthelat, Chief of the Practical Laboratories at the Paris Superior School of Pharmacy, M. Valeur, Secretary of the French Chemical Society, and MM. Famelart and Simon, have been named Chevaliers of the Legion of Honour. The Cross has also been awarded to M. Veyre, Doctor of Pharmacy at Casablanca.

Dr. Karl von Hell, Professor of Chemistry and President of the chemical laboratory at the technical high school at Stuttgart, has retired.

Dr. Otto Hecht, who has been Professor of Chemistry and Natural Science at Würzburg for thirty years, has passed away at the age of sixty-eight. He acquired a reputation as compiler of Erlenmeyer's "Course of Organic Chemistry."

Professor Monnet, Professor of Analytical Chemistry at the University of Lille, died in his eightieth year. He materially aided in developing the aniline-dye industry.

A school of chemistry for women has been established by Dr. Paula Blum in Berlin. This school enables women to acquire the necessary qualifications to take up positions as assistants in chemical laboratories of all kinds, comprising those of argicultural chemistry, bacteriology, pharmacy, etc. The complete course lasts only one year and combines theoretical instruction with practical work.

The well-known firm of "Deutsche Solvay-Werke A.G.," at Bernburg, have made a donation of 250,000 marks to the Prussian Academy of Science. The occasion was the fiftieth anniversary of the invention of the ammonia-sodium process by Ernest Solvay, of Brussels.

Dr. R. E. Blouin has resigned the directorship of the experiment station at Tucuman, Argentina, and Dr. A. H. Rosenfeld, late Sub-Director at the same station has been appointed to his place. Dr. W. E. Gross, late Technologist and Research Chemist at the Louisiana Experiment Station has also joined the staff at Tucuman.

A new journal is being published at Leipzig by J. Traube, assisted by H. J. Hamburger, V. Henri and J. Loeb, under the title of the *International Journal of Physical-Chemical Biology*.

CURRENT LEGAL TOPICS.

Specific References in Patent Specifications.

By WILLIAM JAGO, F.I.C.

CASES are continually occurring in which protection is sought for inventions which differ but very slightly from others which have been previously patented. One type of these is that in which an inventor seeks to patent some improvement on a previous invention of his own. The danger of the latter patent being rendered void by the anticipation of the inventor's own former patent was referred to in the writer's article on "Ore Separation Patent-Action" in the May number of this journal.

The Patents and Designs Act, 1907, provides a remedy for this difficulty in the law of patents by enacting that the patentee when applying for a further patent in respect of any improvement in or modification of the invention may, if he thinks fit, in his application for the further patent, request that the term "limited" in that patent for the duration thereof be the same as that of the original patent or so much of that term as is unexpired. When the application contains such a request, a "patent of addition" may be granted. Such patent shall remain in force so long as the patent for the original invention remains in force, but no longer, and in respect of this patent of addition no fees are payable for renewal. The patent for the improvement becomes, in fact, merged in the original patent, and is treated as one therewith in the matters both of duration and fees payable. No question of the earlier patent anticipating the later can then arise; but of course the improvement loses all advantage of protection for a longer time. During the first two or three years of the life of a patent, it will usually be thought preferable to take out a patent of addition for what is only a small improvement. The loss of duration of the patent is no very serious set-off against the avoidance of the risk of anticipation and the saving in patent fees. But where a much longer time has elapsed since the date of the original patent, another set of considerations arises. If the improvement is a substantial one, the inventor may very well desire to have the benefit of the full fourteen years' term; and so would much prefer a distinct patent, even though he has to pay more in fees. In such a case it becomes necessary to consider whether the improvement has sufficient utility and novelty of its own, independently of the first patent, to warrant the invention being deemed worthy of a patent on its own merits. The inventor must decide for himself (or through his advisers) on the facts of each case whether it is better to secure the comparatively sure but short term of protection of a patent of addition, or to apply for a separate patent with its

greater risks as well as advantages. Having once made his election in favour of addition, the law removes one element of uncertainty, since it is enacted that the grant of a patent of addition shall be conclusive evidence that the invention is a proper subject for a patent of addition. Further, the validity of the patent shall not be questioned on the ground that the invention ought to have been the subject of an independent patent.

Another type of similarity is that in which the invention of a second person differs only slightly or not at all from that described in a previously granted patent. This similarity may be accidental or may be intentional, but in either case the rights of the prior patentee must be fully protected. The Patents Acts make provision for this by enabling any person to oppose the grant of the second patent on various grounds, among which is that the invention has been claimed in any complete specification for a British patent which is or will be of prior date to the patent, the grant of which is opposed. (To this there is a limitation that the prior patent cited must have been applied for during the fifty years preceding the date of application for the opposed patent.) If this ground of opposition is successful the second patent is not granted. A quaint way of putting the reason for this is the *dictum* that "Virtue has gone out of the Crown" in respect of its first grant, or that the Crown having granted and parted with one monopoly cannot grant the same monopoly over again to a second person. It is extremely unlikely, however, that the two inventors have described their alleged inventions in identical terms, and very possibly the second invention may be somewhat wider than the first. For example, the invention may be one for producing a new chemical substance by means of a reaction which is stated to take place between the temperatures of 80° and 90° C. The second inventor may allege the same invention over a range of from 80° to 92°, or may confine himself to from 90° to 92°. When it comes to a matter of infringement, the courts may hold that a temperature of, say, 91°, or even 92° is so slight a departure from 90°, that not only is there no separate invention, but that the worker of this process at 91° or 92° is in fact infringing the original patent and must be restrained. The Crown, however, in the matter of its grant is in rather a different position. Clearly by the first patent, the manufacture between the temperatures of 80° and 90° is granted to the prior patentee. Whether there is in fact any separate and residual patentable matter that can be made the subject of a grant to a second applicant must depend on the circumstances of the particular case. If the comptroller arrives at the conclusion that there is no substantial difference between the inventions claimed in the two specifications, it becomes his duty to refuse the second patent. Thus when an applicant merely claimed to effect a certain result by the use of one of many salts of chromium from out of those covered by the claim on the opponent's specification, and there was no particular advantage shown in so doing, the patent was refused. Further,

if there is a difference between the two and such difference is immaterial, the patent is refused. Again, if after eliminating matters of common knowledge, nothing in the slightest degree materially different remains to distinguish the applicant's claim from the opponents that could possibly be valid subject-matter, the patent may be refused.

In order to protect the prior patentee, in event of a second patent being granted, the course adopted is to require the second applicant to insert in his specification a reference to those matters of like nature which have been the subject of a previous patent or patents. This reference may be either general or specific. The general reference usually states in broad terms the nature of the particular inventions already patented, and then proceeds to indicate the differences between the applicant's invention and those claimed in prior specifications. The specific, or special, reference refers by name to the prior patent in some such terms as the following: "We are aware of the specification of patent No. — of — granted to —, and we make no claim to anything described and claimed therein." The latter is a much greater protection to the prior patentee than a mere general reference to earlier specifications.

In view of the importance of the whole question, and the difficulty of formulating any very clear principle from the various decisions, the Comptroller has given a ruling in which he attempts to formulate the principles which ought to regulate the practice of the Patent Office in directing specific references or disclaimers by name and number in cases which come before him. He first lays down what he regards as the real underlying principle which should govern the insertion of specific references in the following terms:—

"Is the governing idea, or basic principle of an invention sought to be protected, claimed or protected in a specific earlier patent? In other words, the condition necessary is that the new invention should be based on a definite invention already protected, and the earlier invention should be clearly and unequivocally repeated or involved in the new specification."

The Comptroller next proceeds to divide the cases into two classes: (1) those in which a "master patent" is involved, and (2) where there is no claim to a "master patent."

(1) In case of a "master patent." The term itself is first defined as "confined to cases where there has been the discovery of a new and important pioneer principle—so to speak—which has been embodied in practical form or shape and claimed in general terms. There should be some wide and governing principle not hitherto claimed or described, to bring the invention within the meaning of the term "master patent." Following this definition, the Comptroller lays down a rule which is given below in an abridged form:—

"A specific reference is rightly inserted if the new invention is merely an improvement or amendment on the 'master patent.' . . . The governing principle of the later patent is found

in the former and the reference is rightly inserted in accordance with the principle stated above, because the earlier invention is, in effect, taken and appropriated as the basis of the later."

In cases where there is no proper master patent involved, the general principles are the same, but the conditions are stricter and more severe. The Comptroller lays down the following rule:—

"A specific reference should only be allowed where the following conditions are present, viz.: (a) The patent to which reference is asked should be clear and distinct in its own field and as far as can be gathered free from anticipation. (b) The invention claimed therein must be clearly and unequivocally claimed or included in the later specification. (c) It must be claimed or included substantially as a whole and not merely in part. (d) The improvement or addition claimed by the applicant must be small and insignificant and the governing principle, so to speak, must come from the prior patent."

A warning is given on the question of infringement. It need scarcely be said that there are many patents for improvements, which improvements, though themselves patentable, cannot be used without the licence of the prior patentee of the original invention. Examples will occur to almost every reader, but to cite an exceedingly simple one—A. has patented an invention for making a new compound by the interaction of two known substances—B. finds that it is an improvement to specially prepare one of the substances before the interaction and obtains a patent for this improvement. Now, although B.'s patent may be a good one, no one can make use of it without the permission of A., since to do so would infringe A.'s patent for the manufacture of the new compound in whatever way treated before the action. It is so necessary to mention this because the public are apt to regard such second patent as conferring a right on them to use the prior patent without any licence from the prior patentee. It need scarcely be said that any such view or representations are entirely erroneous. Conversely, a licensee under the earlier patent could not use the improvement without a licence from the second patentee. For this reason, it becomes of importance that subsequent specifications should be most carefully watched by the owners of important patents. It may very well be that the subject-matter of the alleged improvement is simply common knowledge, and if the patenting of this be permitted without opposition, the users of the earlier invention may find themselves unable to employ methods that were well known at the date of that invention without running the risk of an action of infringement at the instance of the second patentee. The Comptroller has, therefore, issued the following warning:—

"I do not indeed think that it is any part of the Comptroller's duty to consider the question of infringement; or that the public can ask this Office to protect it by special reference or otherwise where infringement is likely or possible. . . .

I think, however, the public have a right to be warned, as far as possible, of what is special, and what is matter of common knowledge. In certain cases, also, it may amount to a disparagement of the invention of a prior patentee to state it in terms of common knowledge, and the practice is thus rightly open to objection."

There is a final summing up of the position in the following words:—

"Finally, in all that has been said above on the question of specific references it has been assumed that there is some patentable invention involved in the proposed patent, and that it has escaped rejection on the ground of complete anticipation."

This brings us back to the general position, that where there is really no subject-matter in the proposed patent, the proper course is that the grant should be absolutely refused.

THE ROYAL SANITARY INSTITUTE CONGRESS AT BLACKPOOL, JULY 6TH TO 11TH.

By OUR SPECIAL CORRESPONDENT.

THE twenty-ninth Congress of the Royal Sanitary Institute opened at Blackpool on Monday, July 6th, with an address from the President, Lord Derby. An attendance of over 1,400 delegates and members was attracted by the large number of important subjects planned for discussion during the Congress week. An Exhibition of Health and Sanitary Appliances was held in connection with the gathering, and the Congress was considerably above the average of recent years in attendance and interest.

It is, of course, impossible within the limits of this brief notice to give any connected and detailed report of the Congress proceedings. These were carried on in four sections, and embraced conferences of sanitary authorities, medical officers of health, port sanitary authorities, engineers and surveyors to county authorities; special meetings of sanitary and veterinary inspectors were also held. Over 100 addresses and papers were in fact presented and discussed during the Congress week, some of these being of great importance.

Below, brief abstracts of a few of the papers likely to prove of special interest to readers of the CHEMICAL WORLD are given, followed by the titles and authors of others, for which space fails.

I. "THE ACTION OF SOME METALS UPON CERTAIN WATER AND OTHER BACTERIA," by PROFESSOR DELEPINE (Manchester University), and DR. A. GREENWOOD (Kent County Council).—The authors have carried on the investigation of this subject on the lines suggested by Meade Bolton's earlier work at the Johns Hopkins University (U.S.A.), and in this paper they give the results obtained in the pathological and public health laboratory of Manchester University. Their general conclusions are as follows:—

Pure platinum, gold and tin, which do not seem to be appreciably acted upon by water, or by the organic media used in our experiments, did not appear to have any action on the four kinds of bacteria experimented upon. *Lead, aluminium and iron*, which were distinctly acted upon, were either without appreciable effect (lead), or had only a slight inhibitory action (aluminium and iron). *Copper, silver, zinc and mercury* had a powerful inhibitory action, and also

showed evidence of being acted upon by the media, and of forming certain compounds, the nature of which will be discussed elsewhere. In all cases where a marked inhibitory action was produced it was noticed that in reduced doses the metals were also capable of an excitatory action, which resulted in increased growth of bacteria.

It will be noticed that all bacteria were not affected in the same way and to the same extent. The action of soft water upon copper and upon lead is very rapid, but while the passage of lead into the water does not appear to affect the bacterial contents, that of copper is attended with complete, or almost complete, sterilisation in about half an hour.

II. "WHITE LEAD AND ITS DISUSE FOR PAINTING," by SIR HENRY TANNER.—The author in this paper discussed the well-known objections to the use of white lead, stating that, although painters suffered considerably from lead poisoning, no compulsory reporting of such cases occurred, since "house-painting" did not come under the Factory Acts. The substitutes for white lead that have been tried are zinc oxide, barium sulphate, lithopone, etc., but the first-named is now regarded as the only serious competitor of white lead.

Experience has shown that zinc oxide, as a paint base, is a good substitute for white lead for ordinary purposes in white and light shades. In colour and wear it has stood well, internally and also externally, particularly when used on old lead paint. Trouble has been experienced with sealing in some cases, chiefly on hard or damp woods, most pronounced when priming has been of zinc oxide, and probably aggravated by the use in excessive quantity of driers, to make a quick-drying paint at the expense of toughness and permanence. Experiments are being made by which it is hoped that this defect will be overcome, but the importance of employing a minimum quantity of driers, and that of a flexible character, cannot be overrated. Difficulty has also arisen with dark colours, such as green and brown. Such paints could be easily produced which would be quite satisfactory for a time, but after a winter's exposure become soft and are easily rubbed up. Chemists and paint manufacturers were consulted, but without effect for some time. It was, however, found that if a small quantity of litharge (or if the zinc oxide made by the direct process, from the ore, which has 5% to 7% of combined lead salts) were used considerable improvement was effected, the addition acting as a toughener from which little harm can arise to the workers. It is, therefore, thought desirable to allow lead in mixed paints to the extent of, say 5% generally and 11% in greens, for the present.

It is important that the pigment should be very finely ground, and not varied in size, so that when spread the particles are evenly covered by the oil or varnish mediums. It is very desirable that there should be some standard of fineness, and until this can be laid down no stipulation can be made in the specification.

The character of the medium is of equal, or greater, importance, and refined boiled linseed oil is, without doubt, one of the best mediums for zinc oxide paint, because of its paleness and superior drying qualities. It is satisfactory for undercoats—but oils used alone give rise to a ropery, uneven surface as a finishing medium. This defect is effectively overcome by the addition of a certain proportion of good oil copal varnish, which also improves the appearance and protective power of the paint.

III. "DISINFECTION WITH CURRENT STEAM AND FORMALDEHYDE VAPOUR UNDER REDUCED PRESSURE," by DR. JOHN DALE (Birmingham) and DR. T. S. HIGGINS (London).—The method of disinfection of infected articles

that is most employed in this country at the present time is to subject them to the action of steam. This is done in various ways. In some processes current steam is employed at atmospheric pressure, and in some apparatuses of this type the steam is superheated. In the form of apparatus most commonly used, however, the disinfecting agent is saturated or slightly superheated steam at a considerable pressure, often about 20 lbs. to the square inch.

From the point of view of efficiency, this last type of apparatus is excellent, provided that it is properly managed, and that the chamber is not too tightly packed. The water vapour has considerable penetrating action, and its temperature leaves a considerable margin of safety. The chief disadvantage of the process is the damage that it causes to many kinds of articles that have commonly to be sterilised. Such damage is usually due either to: (1) Injury to the substance of the article by steam at the high temperature employed, or (2) the fixing of stains.

It is well known, for instance, that leather is spoiled by pressure-steam disinfection. The ordinary mattress which comes for disinfection is provided with leather tabs, and these are destroyed by the process.

More important than this is the relatively slighter damage that is done to woollen fabrics. The value of a new blanket is distinctly diminished by a single disinfection with pressure steam, the change showing itself by a hardening and shrinking of the fabric, and a deepening of the yellow colour.

The principal object of this paper is to point out that by a slight and inexpensive modification the ordinary Washington-Lyon steam disinfector, fitted with an aspirator, can be used for disinfecting with formaldehyde water vapour at reduced pressure, without impairing its convenience for the ordinary pressure-steam method; and that the formalin process, while being a reliable method of disinfection with marked penetrating power, does not harm or stain many fabrics and materials which it is impossible to disinfect with pressure steam without damage.

The process may be briefly described as follows:—

The formalin boiler is charged with a 2% formaldehyde solution (5 parts per 100 of commercial or 40% strength). The apparatus is warmed by means of the radiator until the temperature in the chamber reaches 60° (*circa*). The chamber is then loaded, and the aspirator is set going to produce a vacuum. The stop-cock on the tube connecting the formalin boiler and the chamber being opened, the steam coil is turned on to heat the formalin solution. In a short time (five to ten minutes) a vacuum of 15–20 ins. of Hg is produced in the chamber and in the formalin boiler, and the solution in the latter soon begins to boil, the vapour being drawn into and through the chamber.

IV. "AIR POLLUTION BY COAL SMOKE, AND SOME REMEDIES," by J. C. DAWES, A.R.S.I.

V. "PAPER AS A HYGIENIC MATERIAL FOR DOMESTIC ARTICLES," by DR. S. RIDEAL.—Other utilities than the ordinary ones are conferred by four of its qualities:—

(1) Its plastic nature: it can readily be rolled or pressed into any shape, and made within useful limits into any degree of softness, hardness or tenacity; (2) it is insoluble in water and in dilute chemicals; (3) it has a high degree of permanence in air at ordinary temperature; and (4) it is easily cremated, or got rid of by burning. These properties make it adaptable for purposes we are about to discuss.

At one of the largest London hospitals there is a regulation that all crockery, cutlery, and glass should be rinsed in a disinfectant, before being used again. In these days of typhoid and diphtheria "carriers" the public are entitled

to expect the adoption of similar precautions in places of refreshment, but these are seldom taken on account of the expense.

The substitution of paper for glass and earthenware would surmount this difficulty, by providing a cheap and attractive tableware that could be burnt after use. Paper cups are already largely used on the Continent, for dental work and public fountains, and the danger of infection from common drinking cups is now generally recognised. Dr. C. F. Tonney, of Chicago, examined a number of cups taken from schools, stores, hotels, etc., and found several pathogenic forms of bacteria present, including the germs of diphtheria, pneumonia, and influenza. Epidemics of disease have been actually traced to the common use of drinking cups.

OTHER PAPERS.—“Blood Changes in Lead Workers,” by Arthur Sellers; “The Improvement of Water in Public Swimming Baths,” by A. Pollard; “The Sanitary Side of Town Planning,” by Alfred J. Price; “The Washing of Woollens,” by A. E. Garrett; “Recent Experiments in Sewage Treatment,” by J. D. WATSON; “The Sampling of Sewage and other Liquids,” by G. B. Kershaw; “Some Conditions influencing the Purification of Polluted Rivers,” by J. E. Purvis and E. H. Black; “Note on the Self-Purification of a River in an Industrial District,” by J. Crabtree; “The Foaming of Sea-water when agitated and its Influence on the Rate of Re-aeration,” by Professor Letts and Chas. W. Addy; “Some Points in the Administration of the Sale of Food and Drugs Acts, and of the Fertilisers and Feeding Stuffs Acts,” by T. R. Hodgson and C. L. Claremont.

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

CHAPTER VI. (*continued*).

HYDROGENATION OF OILS.

LIQUID vegetable oils are of much lower value than solid fats, the former being in many cases produced as a by-product in the manufacture of the solid varieties, and on this account chemists have repeatedly attempted the conversion of the one into the other.

The nature of the problem will be understood when it is recalled that most liquid oils are made up of olein, the triglyceride of oleic acid, whereas solid fats are largely stearin or palmitin, the triglycerides of stearic and palmitic acids respectively. Moreover, oleic acid itself is a liquid, whilst stearic and palmitic acids are solids. A glance at the constitution of these acids reveals the important fact that, whilst oleic acid is unsaturated, the two remaining acids are saturated, oleic acid, however, otherwise corresponding to stearic. Reduction, therefore, should bring about the conversion of oleic into stearic acid, and of other unsaturated acids, such as erucic, linolic, linoleic, etc., acids into the corresponding saturated compounds; but, for many reasons, so simple a solution of the problem proved impracticable until Sabatier and Senderens introduced their method.

Previous processes on other lines had not met with much industrial success. The only one which proved of any value involved the treatment of oleic acid with strong sulphuric acid and subsequent separation by distillation of the resulting hydroxystearic and other solid acids (Frémy).

Soon after the publication of the researches of Sabatier and his co-workers, patents were taken out by Leprince and Siveke (1902) in Germany, and by Normann (1903) in England, for processes based upon their principle. The latter patent, it is interesting to note, already widely known by reason of its alleged fundamental character, has recently been revoked (see CHEMICAL WORLD, 1913, 2, 325). Since the time of these patents many others have

appeared for modification in the working of the process, for improved machinery, etc. The work of Willstätter and of Paal in the first-named connection has already been mentioned.

It was a feature of the above patents that, whilst saturation might be effected by causing the vapours of the oil together with hydrogen to pass over the catalyst, hydrogenation results in a satisfactory manner merely by exposing the oil in the *liquid* condition to the action of hydrogen and the catalyst. The significance of this will be realised when it is remembered that glycerides cannot be vaporised without undue decomposition. As a result of this discovery, then, the working material is not usually gasified as a preliminary to hydrogenation, but is brought into contact with the catalyst as a fine spray, or the catalyst is added to the liquid and intimate contact ensured by agitation or other means. In any case, the oil is heated to a suitable temperature, about 200–250° C., whilst purified hydrogen is injected into the catalyser. The hydrogen is usually under a pressure of a few atmospheres, but this is not indispensable. Indeed, it has been shown recently that reduction can take place even under reduced pressure (Zelinsky). For an account of the various kinds of apparatus employed, see *Journ. Soc. Chem. Ind.*, 1912, 31, 1155.

The two essentials of the process are concerned with the production of an active catalyst and with the problem of a cheap hydrogen supply.

With regard to the former, some form of nickel is generally employed, because of its low cost and high efficiency. But recently palladium has received some attention, on account of its extreme efficiency though its initial cost is against it; whilst other metals, *e.g.*, platinum, copper, iron, etc., have been used to some extent.

The hydrogen necessary for the process is now available from several sources. By one method, suitable for large plants, steam is decomposed by heated iron sponge with the formation of hydrogen

and ferric oxide, the iron of the latter being regenerated by reduction with water-gas. For small plants the electrolysis of water is resorted to, particularly when electric power is cheap. A very promising method provides for the removal of carbon monoxide and hydrocarbons from water-gas by liquefaction; whilst another involves the passage of water-gas and steam at a temperature of 500°C . over lime containing an iron catalyst.

The resulting "hardened oils" are of great commercial utility. Besides being suited for soap and candle making and as lubricants, there is nowadays the possibility of their utilisation as edible fats. As to the likeliness of this latter application, it is difficult to give any definite opinion, for experts are at present investigating the question of contamination with the finely-divided nickel employed.

The hydrogenation of oils, however, by this method is already being practised on a large scale in England and Germany, and its extensive development in the future can be confidently relied upon.

CHAPTER VII.

WE turn now to a consideration of the catalytic dehydrogenation and oxidation of organic compounds.

DEHYDROGENATION.

When dealing in the last chapter with Sabatier's method of catalytic hydrogenation, attention was drawn to his explanation of the mechanism of the process on the lines of the formation of intermediate unstable metallic hydrides. If now this conception be correct, it would be anticipated that the catalysts employed in that process would be able to unite with hydrogen existing not only in the free state but also in compounds capable of surrendering it. In other words, catalysts of hydrogenation should be catalysts of dehydrogenation too. Such is, in fact, found to be the case, and Sabatier, with his collaborators, has thoroughly explored this field of research.

Apart from the state of the catalyst, fairly high temperature is the essential condition. Since hydrogen is liberated, the reverse reaction then sets in to some extent, but the concentration is not sufficient to produce a very serious diminution in the percentage yield. The most important of the applications of the method are briefly summarised below.

(1) *Degradation of Hydrocarbons.*—All hydrocarbons, when submitted to a high temperature, are decomposed with the partial formation of lower hydrocarbons. In the presence of catalysts, however, the decomposition can be brought about at much lower temperatures and, therefore, with far greater regulation than obtains in analogous pyrogenic decompositions.

Thus, the compounds produced by hydrogenation of stable cyclic compounds tend to revert to the original body if the temperature at which hydrogenation took place be appreciably raised. Cyclohexane, for instance, gives benzene, cyclohexanol regenerates phenol, piperidine reverts to pyridine, etc. The dehydrogenation may even be progressive, as in the case of dodecahydroanthracene, which

loses its hydrogen in the reverse manner of that in which the anthracene initially took hydrogen up.

Ordinary cyclic compounds and chain hydrocarbons, in contact with divided metals at temperatures more or less elevated, also appear to split up step by step into hydrogen and a less hydrogenised hydrocarbon. The loss of hydrogen appears to be accompanied by the scission of the hydrocarbon molecule into CH_3 , CH_2 and CH groups, which then rearrange themselves into a further complex molecule whose empirical formula is poorer in hydrogen than that of the original hydrocarbon.

Only by the postulation of such an hypothesis can the curious results obtained by passing various hydrocarbons over heated nickel be explained. If acetylene, for example, be treated under these conditions at 250 — 300°C ., carbon and hydrogen are produced, together with certain hydrocarbons. These latter, if hydrogenated at 180°C ., yield a liquid closely resembling Baku petroleum; whereas, if the temperature be raised to 300°C ., Galician petroleum is the product. From acetylene and hydrogen at 250°C . or so, the condensed product resembles the petroleum of Pennsylvania, being a fluorescent mixture of the typical hydrocarbons.

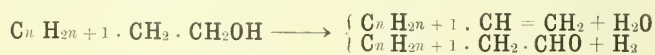
The whole reaction is a combination of hydrogenation, dehydrogenation, decomposition and polymerisation. Anyhow, it has thrown considerable light upon the *raison d'être* of the petroleum found in the earth's crust. For while some authorities consider this to be formed by the action of water on metallic carbides or by the destructive distillation of animal matter far beneath the surface, Sabatier argues that strata of reduced metal, at the temperatures which characterise the upper portions of the earth's crust, play the predominant part by promoting such a reaction as the above between the simpler hydrocarbons and hydrogen which result from the interaction of water and carbonaceous matter at the high temperatures prevailing in deeper regions.

While dealing with this subject, attention should be turned to a very recent process for the conversion of petroleum into petrol. In this process, a continuous feed of petroleum and of hydrogen under pressure are passed from the bottom into a still containing nickel as the catalyst, which is heated to a degree sufficient to vaporise the resulting petrol. The latter is carried away by the hydrogen to the condenser, while the heavier hydrocarbons produced drop back into the still. The explanation of the reaction is as follows: Petroleum, a saturated compound, is decomposed and dehydrogenised with the production of a saturated compound such as petrol, and a heavier unsaturated compound, which immediately takes up hydrogen to form a saturated body, and this again splits up into petrol and an unsaturated compound. And so the cycle is repeated indefinitely until the nickel becomes inactive and the petroleum in the still is overloaded with tarry matters.

In the degradation of hydrocarbons generally, finely-divided and recently-reduced nickel displays the greatest activity. Cobalt is somewhat less

active; iron begins to behave as a catalyst above 350°C ., and platinum, as well as copper, above about 400°C .

(2) *Dehydrogenation of Alcohols*.—Long ago it was observed by Berthelot that the vapours of alcohol when passed through a hot tube suffer decomposition at 500°C . into ethylene and aldehyde. That is to say, under the influence of heat, both dehydration, or loss of water, occurs, and dehydrogenation, or loss of hydrogen. Subsequent experiments have shown that all primary alcohols decompose in this way when subjected to a temperature of about red heat. The simultaneous dehydration, and dehydrogenation may be represented thus:—



Secondary alcohols under similar conditions revert even more readily into unsaturated hydrocarbons and ketones.

By the aid of catalysts, now, the decomposition can be realised at much lower temperatures. And, what is of greater importance, one or other of the two reactions can be made to predominate according to the nature of the catalyst selected.

Finely-divided metals, such as copper, cobalt, nickel, iron, platinum, and palladium, catalyse almost exclusively the dehydrogenation process. The same applies to a small number of anhydrous oxides, chief among which are the lower oxides of manganese, tin, uranium, molybdenum, vanadium and cadmium, though the activity of these is less than that of the metals.

Other metallic oxides, on the contrary, such as thoria and alumina, are catalysts only of dehydration; whilst there exists, too, a large number of substances which can function to a varying degree as catalysts for both reactions. With the question of dehydration, however, we are not concerned in the present chapter.

The dehydrogenation of alcohols, both primary and secondary, is most readily effected by reduced copper. If a fatty alcohol be passed over this catalyst at 200 — 300°C ., a yield of at least 50% aldehyde or ketone can usually be condensed. Of the remainder, a very small percentage consists of superior products, whilst the larger proportion consists of the original alcohol, produced by the action of the disengaged hydrogen upon the product of the reaction in the presence of copper at about 200°C . As pointed out before, however, the conditions are favourable to splitting, because of the smallness of the hydrogen pressure. By working under reduced pressure, the inverse reaction can be diminished and at the same time the volatilisation of the alcohol rendered easier.

Cyclic alcohols may be dehydrogenised in a similar way. Borneol, for instance, can be transformed into camphor by passage over reduced copper at 300°F ., whilst geraniol under similar conditions gives citral. The former fact is utilised industrially in the treatment of certain camphors which are sold very cheaply on account of their

large content of borneol. As the usual process for removing borneol by means of nitric acid is very slow and unsatisfactory, the above dehydrogenation method, which yields nearly pure camphor, has found ready application in this field.

Of the other catalysts, cobalt, iron, platinum, as well as the above-mentioned oxides, are less advantageous. Zinc is stated to possess high activity. Nickel is ruled out on account of the violence of its action, for it pushes decomposition too far.

The general design of the apparatus employed by Sabatier and Senderens, to whom we owe most of our knowledge of this subject, is the same as that shown in Fig. 11, except, of course, that the leading-in tube for hydrogen is suppressed.

We come now to the most important of the industrial applications of this reaction, viz., the preparation of formaldehyde from methyl alcohol. At the outset, it may be remarked that the classification of the process as a dehydrogenation instead of an oxidation process is, as will be seen later, in accordance with recent established opinion upon the theory of the subject.

The earliest recorded production of formaldehyde is to be found in the classic experiment of Hofmann's (1867), in which a red-hot coil of platinum wire suspended over methyl alcohol in a beaker continues to glow there so long as it is in contact with a mixture of the vapour and air.

This method forms the basis of most of the subsequent attempts and of the present commercial process. Thus, in Trillat's method (1889), which was the first proposed for large scale production, crude methyl alcohol was evaporated and passed, together with air aspirated in, through a heated vessel containing platinised asbestos. The containing vessel was heated to dull or red heat according to the nature of the catalyst, which might be copper oxide, porcelain, firebrick, coke, etc., instead of platinised asbestos.

Copper gauze, moreover, had previously been proposed by Tollens and Loew, and in modern plants this is the usual contact substance, though sometimes it is silver-coated. Occasionally silver itself is employed, whilst recently gold has been stated to possess the greatest activity. These metals, of course, are distributed over an earthenware surface. The alcohol is not now evaporated and mixed with air, as in Trillat's method, but air is driven through wood spirit kept at a temperature suitable for saturation and the mixture then passed into the catalyser. For this purpose, scrubber and carburettor arrangements have been proposed.

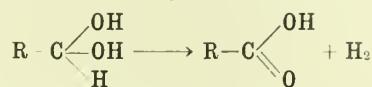
An innovation, due to Orloff, is of interest from our point of view. In order to start the oxidiser without the application of external heat, small pellets of platinised asbestos or pumice, known as "ignition pills," are arranged so that the gases come into contact with them before reaching the catalyst proper.

Although the bulk of the world's production of formaldehyde is obtained from methyl alcohol, various proposals have been brought forward for

the employment of other initial materials. The oxidation of methane, for instance, has been suggested by Glock (1898). The hydrocarbon, or gases containing it, is mixed with an equal quantity of air and passed through a tube containing granulated copper, pumice or asbestos heated to 600°C. After cooling, the remaining uncondensed products are again passed through a second tube of contact substance, and this is repeated until all the methane is oxidised.

Theory originally considered the production of formaldehyde from methyl alcohol as essentially a process of oxidation, with a secondary oxidation to formic acid, carbon dioxide, carbon monoxide and water. No evidence of formic acid, however, can be found, but always a trace of hydrogen. These facts are in accordance with the established explanation, put forward by Le Blanc in 1911, that the main reaction is one of dehydrogenation, on the lines of Sabatier's catalytic decomposition of alcohols generally into aldehydes or ketones.

Wieland has recently attempted to show (1913) that many apparently true oxidation processes are really processes of dehydrogenation. The oxidation of an aldehyde, for example, may be regarded in this light, for in the form of their hydrates, aldehydes are deprived of hydrogen to give acids.



Indeed, oxidation and reduction may both be regarded as results of the same process, viz., dehydrogenation.

Furthermore, in so many cases, a catalyst deprives a substance of its hydrogen, losing its activity in so doing, and the activity is only restored by treatment with oxygen or in the presence of another hydrogen acceptor or reducible body. This explains why such substances as palladium, copper, etc., act as catalysts both of oxidation and reduction processes.

(To be continued.)

SURFACE TENSION AND SURFACE ENERGY AND THEIR INFLUENCE ON CHEMICAL PHENOMENA.

By R. S. WILLOWS, M.A., D.Sc., and E. HATSCHEK.

CHAPTER VI.

IN the preceding chapters a large number of relations between surface tension or intrinsic pressure and other physical and chemical constants have been given—some theoretical and some empirical. We have now to deal briefly with an attempt to connect surface tension with another property of solutions—their osmotic pressure—not so much because this attempt can be called at all successful, but because it has received a good deal of attention, especially in biological work. The reader must be assumed to possess a general knowledge of the theory of osmotic pressure, but, as we shall have to refer to the subject again in connection with the important phenomenon of adsorption, a few remarks on this theory may be useful.

If a solution and the pure solvent are separated by a semipermeable membrane, the solvent tends to pass through the membrane into the solution, and the osmotic pressure is the pressure that must be applied to the latter to keep the solvent from entering into it. The term "osmotic pressure of the solution" is, therefore, strictly speaking, incorrect, as osmotic pressure is, according to the definition, produced only when the solution is separated from the solvent by a semipermeable membrane. If this is remembered, it disposes of the objection sometimes raised that osmotic pressure "works the wrong way," in that it causes motion from places of lower to places of higher osmotic pressure. It is osmosis which causes osmotic pressure, and not osmotic pressure which produces osmosis.

The simple theory of osmotic pressure developed

by Van't Hoff is well known. According to it the molecules of solute behave like gas molecules, and produce the same pressure as would be produced by an equal number of gas molecules occupying the same volume at the same temperature. This leads to a formula for the osmotic pressure which is formally identical with that connecting pressure, temperature and volume of a gas, viz. :—

$$p = R\theta c$$

where p is the osmotic pressure, θ the absolute temperature, c the concentration, expressed in grammes per cubic centimetre, or more usually in gramme-molecules per litre, and R a constant depending on the units in which the concentration and pressure are expressed.

From the assumptions made in deducing it, it appears that this formula is inapplicable to any but dilute solutions. At higher concentrations the discrepancies become considerable between the osmotic pressures actually measured and those calculated from Van't Hoff's equation. The following figures for cane sugar may serve as an example :—

c	p (observed)	p (calculated)
180 gm/litre	13.9 atm.	11.8 atm.
750 gm/litre.	133.7 atm.	49.4 atm.

The attempt to show that surface tension phenomena were the cause of osmotic pressure was first made by Jäger, and his theories were vigorously supported and developed by Traube, whose conclusions we shall state and examine briefly. He finds that the more a dissolved substance reduces the

surface tension of water the greater is the velocity of osmosis of the solution. Hence he concludes that it is the difference in the surface tensions of solvent and solute which determines the direction and velocity of osmosis. The direction of flow Traube obtains by the following consideration: let M (Fig. 7) be a membrane separating two liquids A and B. The molecules of each liquid are then drawn into its interior—*i.e.*, A to the left and B to the right—by the cohesion or intrinsic pressure. If the intrinsic pressure of A is greater than that of B, the latter liquid will pass through the membrane, or will have the power to do so. Since a large intrinsic pressure means a large surface tension, this is equivalent to saying that B passes into A if the surface tension of A is higher than that of B.

If the membrane is removed and A is a solution while B is water, then B (water) diffuses into A (solution), but not A into B.

Traube further expands these considerations by applying them to the explanation of solubility. He ascribes the process of solution to the difference in the surface tensions of the solid and liquid, and assumes that saturation is reached when the two surface tensions have become equal.

It may be remarked here that Traube's theory is rather a theory of osmosis than of osmotic pressure and that, as regards the latter, it has proved incapable of giving any numerical results. It is also open to a number of grave objections, which we will state very briefly. A solution of salicin in water has lower surface tension than water, yet water passes into it through a membrane, as it also does into a mixture of ethyl alcohol and water. According to Traube's theory this should be impossible. A further deduction from it: that a membrane which is impermeable to a substance in solution, when the latter has a higher surface tension than the solvent, should become permeable on the addition to the solution of a substance which lowers the surface tension, has also been proved incorrect by experiment.

In view of the great importance of osmotic phenomena in organisms and of the difficulty of explaining many of them by the classical theories, Traube's views have received some attention from biologists and have given rise to various investigation, one of which deserves mention. This was carried out by Czapek, with the object of determining the "surface tension" of the contents of plant cells. He made solutions of various organic substances, in which the cells were immersed, and noted the concentrations at which the contents just began to diffuse outwards. In accordance with Traube's theories he assumed that at this point the

surface tension of the solution and that of the plasma were equal. Exosmosis occurred with all solutions when their surface tension was reduced to .65 to .68 that of water, whence Czapek concludes that this is the surface tension of the cell contents. While we cannot consider this conclusion warranted, the fact that solutions of equal surface tension produce exosmosis is certainly remarkable. It seems probable that an explanation may be found in adsorption, as has been the case with many "poisoning" phenomena which could not be explained by osmotic pressure alone.

CHAPTER VII.

In the preceding chapters we have availed ourselves of only one of the theories of surface tension, that of Laplace. It has led us directly to recognise an important property of liquids—their cohesion or intrinsic pressure—and has enabled us to establish several theoretical relations between surface tension and other constants. It is, however, incomplete in one particular, inasmuch as it assumes that there is a perfectly sharp line of demarcation between the two media bounding the surface, for instance, between liquid and air. We need not discuss whether such an abrupt transition is intrinsically probable, as there is a large amount of evidence, principally optical, to show that there is a gradual change in density and in other properties from those of one medium to those of the other. It can, for instance, be shown that plane polarised light should be reflected again as plane polarised light, and, therefore, be capable of being completely extinguished by a Nicol prism, if the transition from one medium to the other were abrupt. Actually this is never the case with an old surface, especially in the case of metals, but the light is always elliptically polarised. With perfectly fresh surfaces this is not the case; thus Lord Rayleigh showed that the ellipticity nearly disappeared at the boundary air-water if the surface of the latter was constantly renewed, and Drude proved its absence on the surface of a freshly split crystal.

To account for the phenomenon it is necessary to assume a film of different density on the surface, of which the order of magnitude of the thickness can be calculated, approximately; it is about 10^{-7} cm. for the surface crown glass-air. We shall have occasion to refer to this surface film again. There is also other experimental evidence for its existence; it is, for instance, a common experience in vacuum tube work that, after first pumping down and allowing the apparatus to stand, the pressure rises again owing to gas coming off the walls. Baly and Ramsay found it nearly impossible to test Boyle's law at very low pressures owing to this released gas, the amount of which varied with temperature and pressure.

The existence of such transition layers was not recognised by Laplace, but has actually been made the basis of theories of surface tension in more recent times. As these are very largely mathematical, only the briefest reference to the fundamental assumptions and the principal conclusions

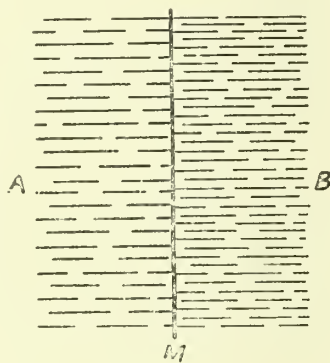


FIG. 7.

is possible here. The first step was taken by Gibbs, who still assumed that there is discontinuity at the boundary of two media, but that at the same time the layers of both media immediately adjoining the boundary had densities, etc., different from those of the bulk. If this assumption is granted, it can be shown that a surface tension must exist at the boundary. Gibbs developed his theory chiefly in one direction: the difference between the composition of the surface layer and that of the bulk of the medium, and we shall have occasion to refer to his work again when discussing adsorption.

Van der Waals, whose theory has been further developed by Hulshoff and by Bakker, went one step further than Gibbs by assuming that there exists a perfectly continuous transition from one medium to the other at the boundary. This assumption limits him to the consideration of one particular case; that of a liquid in contact with its own saturated vapour, and mathematical treatment becomes possible by the further assumption that the Van der Waals equation (see Chapter II.) holds good throughout the system. The conditions of equilibrium thus become dynamical, as opposed to the statical equilibrium of Laplace's theory. Van der Waals arrives at the following principal results: (1) that a surface tension exists at the boundary liquid-saturated vapour and that it is of the same order of magnitude as that found by Laplace's theory; (2) that the surface tension decreases with rising temperature and disappears at the critical point; and (3) that the thickness of the transition layer increases with rising temperature and becomes infinitely large at the critical point—which is obvious when we remember that at the critical temperature there is no difference between liquid and saturated vapour.

Van der Waals further finds a relation between the temperature coefficient of surface tension and the molecular surface energy which is in substantial agreement with the Eötvös-Ramsay-Shields formula (see Chapter V.). He also arrives at a value for the thickness of the transition layer which is of the order of magnitude of the molecular radius, as deduced from the kinetic theory, and accounts qualitatively for the optical effects described at the beginning of this chapter. Finally, it should be mentioned that Van der Waals' theory leads directly to the conclusion that the existence of a transition layer at the boundary of two media reduces the surface tension, *i.e.*, makes it smaller than it would be if the transition were abrupt—a result obtained independently by Lord Rayleigh.

(To be continued.)

UNIVERSITY NEWS.

Mr. Fredk. Soddy has been appointed to the Chair of Chemistry at the University of Aberdeen, in succession to Prof. Japp.

Dr. T. S. Moore has been appointed to the Chair of Chemistry at the Royal Holloway College.

The degree of D.Sc. (Lond.) in Chemistry has been conferred upon Mr. David Segaller, a student of the South Western Polytechnic.

ENGINEERING NOTES.

By R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

Chemical Water Consumption Gauge.

On May 15th a short notice appeared in *Engineering* of a method for estimating the very large water consumption of an hydraulic turbine in the Ventavon works of the Société de l'Energie Electrique der litoral Mediterranee. The method is very simple; the water in the normal course (presumably) has no sodium chloride in it; a constant stream of concentrated sodium chloride is delivered into the inflow water of the turbine and the outflow is titrated with silver nitrate to show the concentration.

This turbine was tried at various known loads and showed very satisfactory agreement. The masses of water passing through at full and half load were about 12,500 litres and 6,500 litres, and at full load one litre of salt solution was introduced a second.

This method has the great advantage that for use it requires only the most meagre and inexpensive apparatus and the cost of the solution is small for short periods—if the method were employed continuously we fancy that it would come dear.

The article did not point out what the present writer has stated above—*i.e.*, that the water was commonly free from salt; as Mr. F. van Irterson pointed out in his letter to *Engineering* of May 29th, common salt solutions would probably be a poor guide in water already containing the same, for the concentration of the turbine water itself would probably vary from time to time to an even greater extent than the "load diminution" of the injected solution.

As the water with which Mr. van Irterson's drainage pumps have to deal contains salt (NaCl) he uses sodium hyposulphite and titrates with iodine, using potassium iodide and amyl as an indicator. With praiseworthy thoroughness he gives all the bibliography on the subject to date, several of the articles referred to being his own contributions, and this bibliography will be found on p. 743 of *Engineering* for May 29th of this year.

Season Cracking and Other Peculiarities in Brass Rods.

In *Engineering* (issue June 5th, 1914) there is a copy of the paper read by Dr. Stead before the Institute of Metals on Muntz metal. The paper is excellent, and some of the results arrived at by Dr. Stead are most interesting, notably those of his heat treatment tests, while his views on colouring for microstructure are also of great value to those who are constantly dealing with brass rod sections. It is not of these points, however, which the present writer wishes to speak, but of the remarks made by Mr. F. J. Johnson when discussing a paper on copper zinc alloys, which appears as Part IV. of Dr. Stead's paper.

He drew particular notice to hard-drawn rod of the following composition:—

Copper	58.6	} per cent. approx.
Zinc	38.6	
Lead	2.4	
Tin	.3	
Iron	.1	

which had been used as a high-tension conductor through a concrete floor in one of the Cleveland and Durham Power Co.'s sub-stations. After about three years these rods

showed signs of cracking along the body of the rod, but not at the screwed ends of the bar. The cracks were transverse and of the well-known "cuppy" type—that is to say, the bar on fracture broke in male and female cones. He attributed the cracking to three things: the presence of lead in an appreciable quantity, the constant tremor of the bar, and the initial over-working of the same in drawing the uncracked condition of the screwed ends to the protection afforded by the nuts.

Dealing with these remarks in the above order: the presence of lead in the rod is detrimental in two ways, but a great advantage in another, namely, a rod containing much lead usually machines easily. The detrimental characteristics of the lead are somewhat secondary—lead is a heavy metal and in treatment prior to pouring is rarely sufficiently carefully mixed in. This is apt to lead to segregation. The presence of lead greatly cold shortens the rod (hence the good machining qualities), which tend to make a hard-drawn rod much more apt to start "coning" in the process of hard-drawing, because the elongation limit is more rapidly reached by a moderate draft and permanent and unadjustable stresses set up.

The constant tremor of the bar, had it been much greater in the early periods of the bar's use, would possibly have prevented later cracking by its "springing" action before segregation had become at all serious chemically. The initial over-drawing of the bar seems to have been a perfectly unnecessary affair in this case, as the bar had apparently to stand no special mechanical tests which suitable drawing will render it able to support. The uncracked condition of the screwed ends was most probably due to the removal at an early date of the hard tensilely overstressed skin and the slight annealing due to tooling, for these rods are usually turned dry and come from the machine at a good temperature. In the case taken by Mr. Johnson, the rod might, as he suggested, have been suitably annealed after draft, but it would not then have had a hard finish.

A great many rods of very similar metal, however are now produced to Government requirements and the lead in them is (by a fairly rigid Government specification) kept pretty low, and total impurities are specified as not to exceed a small percentage. This rod has, on the other hand, to be carefully drawn to ensure definite physical properties in the testing machine. In spite of all this it is doubtful if the Government always gets what it wants, for when, as is always the case, the rod has been through the automatic lathe its properties would be found to have altered could it then be tested. Further, rods always low in lead, and sometimes virtually leadless, are still subject to season cracking. The conclusion, therefore, is that, provided the lead is properly mixed in, the stresses set up by the (at present) necessary drawing are the chief cause of this failure, and until mixtures are used, which will give the necessary tensile tests after annealing, there will always be a danger of season and other "stress" crackings.

The Oxylene Fire-proofing Process.

In the same number of *Engineering* as that just mentioned the process in the heading of this note is described. The company who engage in this work claim that wood treated by their method does not sweat, nor damage, nor corrode fittings attached to it.

The method of impregnation is a very usual one, the wood is steamed to expel sap and dried under heat and vacuum, and into the chamber in which the wood is thus

treated a solution of ammonium phosphate and boracic acid is finally introduced. They claim penetration to the heart of a 6-in. square teak, and there is no reason why it should not be obtained in the manner stated. After impregnation the wood is thoroughly dried. It is said that the wood will French polish and is altogether like good seasoned timber.

As a good deal of their work is for the Admiralty, it looks as if their product is not subject to a very serious objection to many other fire-proofing compositions, namely, that the impregnator is not readily washed out by prolonged exposure to boisterous wet weather. This is a point where most fire-proofing methods fail, and it would be interesting if they would comment on this possibility when they next refer to their method.

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, *Chartered Patent Agent,*
Queen Anne's Chambers, Westminster, S.W.

23377/12. E. B. HIGGINS. **Catalysis.**

In processes for the reduction of organic compounds by catalysis, a reducing agent, such as an organic metal salt, which furnishes the hydrogen necessary is used.

2213/13. E. GRAEGER and A. KEMMLER. **Silk.**

For quickly removing sericin and opening up raw silk, silk waste and cocoons by treatment with solutions of tryptic ferments, the said ferments, such as pancreatine or papayotinine, are caused to act at moderate temperatures on raw materials previously treated with weakly alkaline solutions, such as weak soda or borax solutions, in the presence of electrolytes with a neutral reaction, such as sodium chloride, and ammonia salts.

3965/13. P. FERRERE. **Zinc.**

An apparatus for reducing spongy zinc oxide by means of carbon comprises a series of retorts, each end of each retort connecting with one of two collectors by means of an extension and a bottle, said collectors being arranged in separate chambers and the whole of the retorts, extensions, chambers and collectors heated electrically.

5873/13. T. RIGBY, W. ANDREW and WETCARBONIZING, LTD. **Peat Treatment.**

A method of freeing the water from peat by heating the wet peat consists in adding acid to the raw peat and modifying the heating conditions of time or temperature or both to take advantage of the accelerating action of the acid upon the desired change.

5921/13. J. C. BUTTERFIELD. **Sewage Treatment.**

A process for the treatment of sewage consists in heating it together with petroleum in a closed retort to a low temperature and collecting the fatty bodies which are contained in the condensed ammoniacal liquor.

9237/13. GESELLSCHAFT FÜR ELEKTRO-OSMOSE, m.b.H. **Silicic Acid.**

Soluble and chemically pure silicic acid is manufactured by subjecting to the action of electric current an alkali silicate solution in the anode compartment of a cell provided with a diaphragm of such potential that it allows the migration through it of alkali and simultaneously prevents the migration of silicic acid.

11257/13. F. E. BLAISDELL. **Vulcanising Rubber.**

In a vulcanising pan consisting of a closed chamber having controlled inlet and outlet pipes and a steam jacket around said chamber having controlled inlet and outlet pipes, means are provided for admitting steam to the interior of the chamber and increasing the pressure thereof by compressed air.

11939/13. F. J. LYSTER. **Metallic Sulphide Ores.**

For the separation of lead sulphide from zinc sulphide in ores containing mixed lead and zinc sulphides, the ores are subjected to a flotation separation treatment with a frothing agent, such as eucalyptus oil, and with agitation or aeration in a neutral or alkaline solution of the sulphates, chlorides or nitrates of calcium, magnesium, sodium, potassium or mixtures of these substances.

18925/13. F. BERGIUS. **Treating Fish Oils.**

A process for the manufacture of light coloured and odourless oils from fish oils consists in a single heating of the fish oil for several hours at a temperature between 250° C. to 300° C. without preliminary treatment and without blowing steam through the oil.

21295/13. J. D. DAVIS. **Desiccated Milk.**

A process of making a flaky, porous desiccated milk consists in concentrating the milk and reducing it to particles containing a small percentage of moisture, pressing the same into a block, and shaving thin shavings from the block.

21725/13. THE FIRM OF A. BERINGER. **Wood Oil.**

A process of converting wood oil into an oil not likely to coagulate on being subjected to heat consists in adding to the wood oil a very small quantity of the following substances or any combination of the same: sulphur, sulphides, selenium, or selenides.

24236/13. C. RUMPF. **Mercerised Cotton.**

For producing on cotton textile goods a permanent lustre capable of withstanding the action of soap and water, the goods are soaked in a solution of an oxidising agent and after such treatment are subjected to a calendering operation under pressure and at the usual high temperature. The lustre so produced is reduced and rendered permanent by steaming the goods or passing them through water or a soap solution.

29827/13. M. SPAZIER. **Sodium Carbonate.**

A process for forming sodium carbonate consists in dissolving soda ash in cold water, agitating the mixture until a complete solution is obtained, exposing the solution to the action of the air for a predetermined period and withdrawing the crystallised product.

2952/14. E. J. HUNT and W. T. GIDDEN. **Zinc Sulphate.**
Zinc sulphate liquors are purified from iron and manganese to fit them for electrolysis by treating a liquor containing iron in substantially the ferrous condition only with peroxide of lead.

11797/14. J. E. BUCHER. **Cyanides.**

A process for making cyanides consists in bringing together nitrogen and an alkali or alkaline earth metal or compound in the presence of molten carburised iron with or without additional carbon.

18856/13. E. HUMBERT. **Steel.**

A method of purifying steel consists in pouring the steel into a finishing vessel containing a molten silico-calcium-carbide slag prepared in an electric furnace so as to convert the silicates of iron and manganese therein into a readily fusible silicate of lime.

12267/13. J. B. MACDONALD. **Tin Ores.**

A process for the treatment of lead-bearing tin ores

consists in mixing the ore concentrates with a nitrate of an alkali metal, then calcining the mixture to form lead sulphate, and finally leaching out the lead sulphate with caustic lye.

12421/13. C. GLADITZ. **Tungsten.**

Metallic tungsten bars or bodies in a condition suitable for mechanical treatment are manufactured from fluffy tungsten powder which is inoculated with a small quantity of a larger cluster crystal derivative. The mixture is pressed into a bar or body and submitted to a treatment which will cause the growth of larger crystals. The bar is then sintered.

12927/13. W. P. DREAPER. **Improvements in Effecting Chemical Reactions between Solid Substances and Gases at High Temperatures.**12979/13. BADISCHE ANILIN and SODA FABRIK. **Ammonium Sulphate.**

Ammonium sulphate is produced by treating ammonium sulphite in solution with oxygen or air in the presence of a solid porous oxygen carrier while maintaining the solution alkaline with ammonia.

13696/13. B. I. LEVIN. **Flour Treatment.**

In flour improving, the flour or stock is treated with an electrolysed solution of the desired improving ingredient.

14937/13. F. E. GALLAGHER. **Fermentable Sugars.**

A process for the production of fermentable sugars by the hydrolysis of cellulosic material under steam pressure in the presence of an acid or equivalent inorganic hydrolysing agent consists in digesting the material until a considerable proportion thereof has been rendered soluble and thereafter continuing the digestion with an inorganic hydrolysing agent at a lower temperature and under pressure.

15020/13. KALLE & Co., AKTIENGESellschaft. **Aluminium Acetate Compounds.**

A process for the manufacture of aluminium acetate compounds soluble in water even after evaporation is characterised by hexamethylene-tetramine being caused to react on aluminium acetate, the solution thus obtained being, if desired, evaporated to dryness.

INSTITUTE OF CHEMISTRY.

PASS LIST: JUNE—JULY (1914) EXAMINATIONS.

The results of the examinations of the Institute of Chemistry recently held in London, Dublin, and Glasgow have now been published.

Of twenty-three candidates who presented themselves for the intermediate examination, eleven passed: A. J. Boyd, R. G. Browning, R. C. Denington, A. O. Jones, J. King, E. Leitch, B.Sc. (Glas.), G. W. Moore, P. D. Oakley, P. W. Rait, E. L. J. Stockdale, B.Sc. (Lond.), and H. M. Webb. Of twenty-eight candidates who presented themselves for the final (A.I.C.) examination, thirteen passed: In the Branch of Mineral Chemistry: H. Trickett and H. Vernon, B.Sc. (Lond.); in the Branch of Organic Chemistry: J. G. Duncan, T. H. Durrans, B.Sc. (Lond.), S. H. Groenewoud, L. A. Jordan, B.Sc., A.R.C.S. (Lond.), L. Orange, B.Sc. (Lond.), W. S. Ritchie, B.Sc. (Lond.), F. W. Snelgrove, B.Sc. (Lond.), J. W. Tait, M.A. (Edin.), and F. D. White; in the Branch of the Chemistry (and Microscopy) of Food and Drugs, Fertilisers and Feeding Stuffs, Soils, and Water: J. H. Christie, B.Sc. (Lond.), and C. G. Collins. Two candidates examined at Johannesburg have also satisfied the Board: In the Branch of Metallurgical Chemistry, D. Millin, B.A. (Cape), and in the Branch of Organic Chemistry, A. Kloot, B.Sc. (Lond.).

REVIEWS OF BOOKS.

"THE FIXATION OF ATMOSPHERIC NITROGEN."

By **Joseph Knox**. GURNEY & JACKSON, London, 1914. Pages 112 + v, with Index and Bibliography. Divided into 11 Chapters, with 8 Illustrations. Price 2/- net.

THIS small volume deals with the increasingly important subject of the fixation of atmospheric nitrogen. The next few years (with the lapse of important patents, and a wider manufacturing interest in these products) will undoubtedly see important developments; the relative importance of the different products will be more fully realised, and possibly new and further openings will be found for some of them.

The author has conveniently divided his subject into three sections, dealing respectively with the fixation as nitric and nitrous acids and their salts, synthesis of ammonia and ammonium compounds from atmospheric nitrogen, and the conversion of atmospheric nitrogen into compounds which readily yield ammonia.

At present market prices for nitrates and ammonium sulphate probably all of these processes could be worked commercially, and in fact are being worked. With a further fall of, say, 25% in prices a different tale might possibly have to be told.

Secondary developments, such as that of the manufacture of cyanides from cyanamide, have not somehow progressed as was at first thought possible. The belief held in some quarters that such products as ammonium nitrate and ammonium phosphate may occupy an increasing position in the fertiliser world may be found to be justified in the long run. If so, the artificial products will certainly score.

At any rate, and allowing a considerable margin for the shuffling of the cards, which may bring to the surface the process which is destined to supersede the others, on account of cheapness of production, and value of the resulting products, the increasing manufacture of these products is bound to profoundly modify the agricultural factor, and also possibly many others of deep concern and importance to the chemist.

"THE ELEMENTS OF CHEMISTRY." By H. LI. Bassett.

CROSBY, LOCKWOOD & SON, London, 1914. Pages 368 + viii, with Index. Divided into 4 Parts, with 27 Chapters and 31 Illustrations. Price 4/6.

The author in this volume has attempted a difficult task, viz. to give within the compass of some 350 pages an account of the elements of chemistry itself.

The value of this work must lie in its adaptability to class work or individual study by the student who is entering for the examinations of the Conjoint Board or first Medical Examinations.

The book is divided into four parts, dealing respectively with general and physical chemistry,

inorganic chemistry, organic chemistry and practical chemistry.

The author has done all that could be expected of him under the conditions of restricted space to put before the student a clear and concise account of the subject considered. The interest of the volume is increased by the preface written by Professor W. J. Pope.

"ALCOHOLIC FERMENTATION." By A. Harden.

Monographs on Biochemistry. Second Edition. LONGMANS, GREEN & Co., 1914. Pages 156. Price 4/- net.

Professor Harden has found it necessary to considerably increase the subject-matter and bibliography in the second edition of this extremely well-written monograph, which is known to all those interested in this important subject. The chapters on the co-enzyme of yeast juice, and the action of inhibiting and accelerating agents on the enzymes, are particularly interesting; also those dealing with the by-products of alcoholic fermentation and the chemical changes induced in the same. It is almost impossible to praise this volume too highly, owing to the extreme care taken by the author, and the satisfactory nature of the text.

BOOKS, ETC., RECEIVED.

"**Principles of Metallurgy**," by Arthur H. Hiorns. Second Edition. Revised and enlarged. Macmillan & Co., Ltd., London, 1914. Pages 389 + vi, with Index. Chapters XXV. with 144 Illustrations. Price 6/-

"**The Examination and Thermal Value of Fuel: Gaseous, Liquid, and Solid**," by J. H. Coste and E. R. Andrews. Charles Griffin & Co. Ltd., London, 1914. Pages 278 + xiv, with Index. Chapters IX. with 63 Illustrations and 8 Plates. Price 6/- net.

"**Clay and Pottery Industries**," Vol. 1. Collected Papers from the County Pottery Laboratory, Staffordshire. Edited by J. W. Mellor. Charles Griffin & Co. Ltd., London, 1914. Pages 411 + xiv, with Index. Chapters LII., with 263 Illustrations and 4 Coloured Plates. Price 15/- net.

"**Metallurgical Coke**," by A. W. Belden. Technical Paper 50, Bureau of Mines, Washington, U.S.A., 1913. Pages 48, with 23 Illustrations and 1 Plate.

"**Notes on the Prevention of Dust and Gas Explosions in Coal Mines**," by George S. Rice. Technical Paper 56, Bureau of Mines, Washington, U.S.A., 1913. Pages 24.

"**The Titaniferous Iron Ores in the United States**," by Joseph T. Singewald. Bulletin 64, Bureau of Mines, Washington, U.S.A., 1913. Pages 145, with 3 Illustrations and 16 Plates.

"**Mining and Treatment of Feldspar and Kaolin**," by A. S. Watts. Bulletin 53, Bureau of Mines, Washington, U.S.A., 1913. Pages 170, with 12 Illustrations and 16 Plates.

"The Influence of Inert Gases on Inflammable Gaseous Mixtures," by J. K. Clement. Technical Paper 43, Bureau of Mines, Washington, U.S.A., 1913. Pages 24, with 16 Illustrations and 1 Plate.

"Sanitation at Mining Villages in the Birmingham District, Ala.," by Dwight E. E. Woodbridge. Bureau of Mines, Washington, U.S.A., 1913. Pages 27, with 9 Illustrations and 1 Plate.

"The Production and Use of Brown Coal in the Vicinity of Cologne, Germany," by Charles A. Davis. Technical Paper 55, Bureau of Mines, Washington, U.S.A., 1913. Pages 15.

"Tests for Permissible Explosives," by Clarence Hall and Spencer P. Howell. Bulletin 66, Bureau of Mines, Washington, U.S.A., 1913. Pages 313 + v, with Index and 6 Illustrations and 1 Plate.

A SIMPLE LABORATORY APPARATUS FOR THE CONTINUOUS EVAPORATION OF LARGE VOLUMES OF LIQUID IN VACUO.¹

By WILLIAM A. DAVIS.

(Rothamsted Experimental Station.)

It is frequently necessary, especially in dealing with plant and animal extracts, to concentrate large volumes of liquid *in vacuo*. In such cases, the operation is often a very tedious one, owing to the necessity of closely watching the apparatus so as to control frothing and avoid the passing over of the liquid into the distillate. Having experienced this, more particularly in the distillation of alcoholic plant extracts, which show a great tendency to froth, the simple apparatus shown in the sketch has been devised which completely overcomes all the difficulties encountered in such work. By means of it large volumes of liquid can be evaporated continuously and the distillate recovered, if necessary in fractions; the apparatus requires practically no watching after the distillation has once been started, and the latter can be left to itself whilst other work is proceeded with. It is only necessary from time to time to renew the liquid in the distilling flask A, by means of the dropping funnel A' (Fig. 1).

The apparatus consists of an ordinary distilling flask with the side-tube bent up and passing into a wide piece of glass tube B which serves as a froth-trap; the latter is connected by glass tubing with the condenser D, the lower end of which passes through a rubber stopper into the cylindrical dropping funnel E, which in turn is connected, as shown, below with the pump-flask G, and above with the large reservoir P, which serves to take up small variations of pressure and thus ensure a steady vacuum throughout the system. In this way regular ebullition, without overheating or frothing, is secured.

The vacuum is maintained by means of an ordinary water injector-pump, connected through a Hutchinson regulating valve J (*Chemical News*, 1912, 99) with the bottle H and thence with E and G; a glass cock is interposed at T, whilst S is a screw-clamp which operates on the piece of rubber pressure-tubing connecting G and H. At M a manometer tube is inserted which shows the vacuum throughout the system. The Hutchinson valve takes up large variations in the vacuum due to changes of water pressure, so that by means of this, combined with the regulating reservoir P, changes in the vacuum are reduced to a minimum.

When the liquid in A first begins to boil there is often a great tendency to froth; should this occur, the froth rises into the trap B, breaks against a disc of copper-gauze, and the liquid is returned automatically to the flask through the piece of glass tube L.

The combination E and G allows of the distillate being removed from time to time; whilst the distillation is proceeding, the vacuum in G is maintained the same as in the rest of the system, so that by opening the glass tap of E the distillate runs down into G. When G is full, and it is required to empty it, the cock on E is closed, and the screw-clamp S screwed down on to the rubber pressure-tube. The latter is then detached from the side tube of G, and the flask G removed from the rubber stopper R, emptied and replaced without interfering with the vacuum throughout the rest of the system. After it has been replaced, S is opened and in a very short time the vacuum is re-established in G, the same as throughout the rest of the apparatus.

It is a very simple matter by introducing T-pieces to

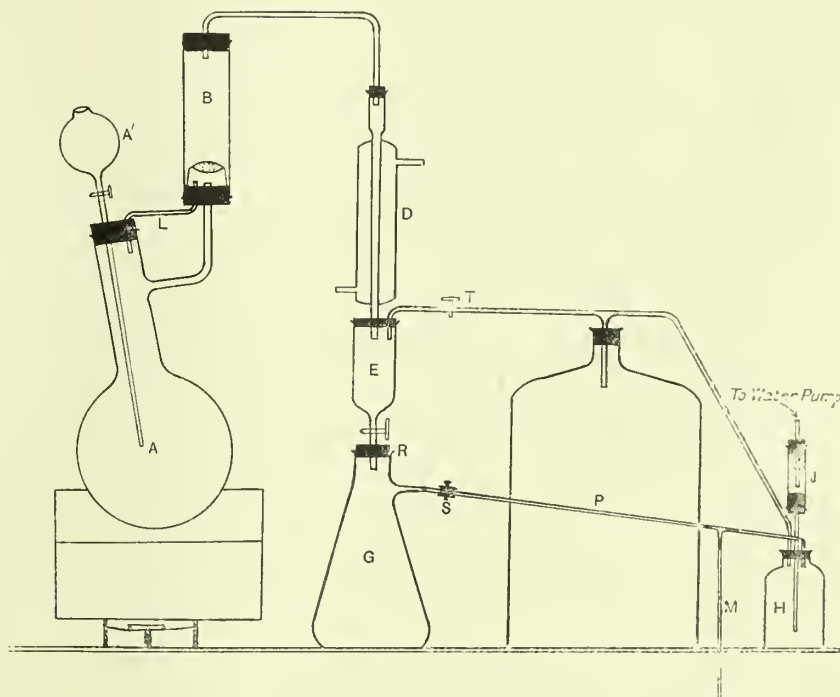


FIG. 1.—AUTOMATIC DISTILLING APPARATUS.

run two or more of these distillation apparatus in conjunction with a single vacuum pump and a single regulating vessel P. We have had such an arrangement in continual use now for over a year and it answers all requirements.

All connections must of course be made with rubber stoppers or rubber pressure-tubing.

¹ Reprinted from the *Journal of Agricultural Science*, Vol. V., Part IV.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

Process of Clarifying Palm Saps.

A new process of clarifying palm saps which promises to be of possible economic importance has recently been devised by Mr. C. W. Hines in co-operation with Mr. O. W. Barrett, both of the staff of the Bureau of Agriculture of the Philippine Government. The process consists briefly in a double precipitation of the impurities in the sap, and this method constitutes a great improvement over the previous methods of handling palm saps, which usually contain such high percentage of albuminoids, gums, resins, etc., with the ordinary massecuite, and are always black and very strongly flavoured, with a small proportion of crystals in the syrup.

The first step in this process is the removal of the albuminous substances by either heat or the introduction of alcohol; either of these methods removes the colloidal precipitates which would necessarily clog the pores of any filtering medium. Heat is usually more economical, but where low-grade alcohol can be had at a reasonable cost, it may be substituted for the pre-heating, in which case it should be introduced directly into the receptacles when they are placed in position for collecting the sap. Both alcoholic and pre-heating methods have given, by the way, equally satisfactory results with sugar-cane juice in the Philippines.

After the pre-heated juice has been allowed to deposit its coagulum—a matter of two or three hours at ordinary temperature—the clear supernatant liquor is drawn off and treated with the ordinary milk of lime (15° Be. to 0·2 cc. against tenth normal sodium hydroxide, using phenolphthalein as an indicator). Carbon dioxide gas is now introduced while the juice is thoroughly agitated until an acidity of 0·7 cc. is reached (either pure gas may be used for this purpose or the combustion gases from the smoke stack—in the latter case the gas being first passed through a washing apparatus to remove soot, etc., before it enters the juice). The lime and carbonated juice which is now filled with the calcium carbonate precipitate is filtered through an ordinary cloth bag, and the gums, resins, etc., are thus readily removed, giving a very clear juice with only a trace of lime salts if the carbonisation is well done.

Disinfectants in China.

The American Consul-General at Hong Kong says that attempts have been made to introduce American disinfectants in this part of the world for public, hospital and household use. Disinfectants are a household necessity in the tropics, and for years British manufacturers have been making them a speciality, the trade having originally been built up in India. Their disinfectants have been well introduced in the Far East and become well known to the native servants. However, most disinfectants now sold at Hong Kong are adulterated and weakened by compounds before sale and by servants before use.

Quinine Supply of India.

The following information is given in an article in the *Indian Medical Record* by Dr. C. A. Bentley, special deputy

sanitary commissioner of Bengal. It is suggested that if the consumption of quinine extends to any great extent in India, which already takes one-sixth of the world's supply, the price will speedily rise. The bulk of the world's supply now comes from Java, but at one time Ceylon produced a considerable amount of cinchona bark. In 1886, 15,000,000 lbs. of bark were exported from Ceylon, but in 1910 the exports had fallen to 80,000 lbs. For a number of years quinine has stood at such a low price that bark producers have had only a small margin of profit. Under these circumstances it is hardly likely that they have continued to plant largely, and there is a great risk, therefore, that a rapid advance in price may take place at any time. Although at present there are some thousands of acres in India planted with cinchona trees, yet, in order to minimise the risk of a great enhancement in the price of quinine in the near future, it would be well if the acreage under cinchona were largely extended. Once in the past the policy of the Indian Government benefited the whole world by a supply of cheap quinine, and it is quite possible that if India takes steps to extend the culture of cinchona at the present time it may not only promote its own interests, but again perform a world-wide service.

Asbestos in Arizona.

H.M. Consul-General at San Francisco reports the discovery of a large deposit of asbestos at a place thirty-five miles north-east of Globe, Arizona, in the Ash Creek district. It is said that the fibre runs from 2 to 6 ins. in length, and is very easily mined, but has to be carried on pack animals to Globe.

Wattle Bark Extract.

A company has been formed at Maritzburg (South Africa) for making wattle extract in solid form. It is estimated that the cost of setting up the necessary plant in Natal will be £20,000, and that the cost of dealing with 6,000 tons per annum will be £3,000. According to a report issued by Mr. Chiappini, the prospects of the business are bright, as, so far, South African growers send all their bark to London, where it is bought up by German extract manufacturers. Last year the value of bark imported into the United Kingdom for tanning purposes amounted to £348,082, as against £922,600 for extracts. Of the former, bark to the value of £275,795, and extracts valued at £32,056 were re-exported, showing that the tendency here is all in favour of the latter.

Oxidation of Arsenical Dipping Fluids.

According to a recent report in the *Rhodesia Agricultural Journal*, the oxidation of arsenites to arsenates in dipping tanks has the effect of impairing the efficacy of arsenical dipping fluids. These investigations were undertaken to determine whether in practice it was necessary to change the dip on account of oxidation. The sodium arsenite and sodium arsenate contained in three dipping tanks in almost continuous use were determined at frequent intervals over two or three months. In each case during these periods fresh dip was added to replace that removed during dipping. From the results it was concluded that

there is no necessity to renew a dip, in which a fair number of animals are constantly dipped at short intervals, until it has become too dirty for use.

Unexplored Graphite Deposits in Bavaria.

Professor Weinschenk, of Munich, recently published an interesting account of large graphite deposits near Passau (Lower Bavaria). According to his description of these deposits, they represent a source of enormous wealth which, when properly opened up, would last for many centuries. The quality of the Passau graphite compares favourably with that of the best Ceylon product, which is, at present, imported in fairly large quantities into Germany, and which would be replaced by the home product, if sufficient capital could be found to work the deposits on a large scale. The consumption of plumbago from Ceylon and Madagascar is constantly increasing, not only on the Continent but also in the United States, and there would be no difficulty whatever in finding a market for the Bavarian mineral, provided the quality is what Professor Weinschenk claims it to be.

Abrasive Garnet in America.

The production of abrasive garnet in the United States in 1913 amounted to 5,308 short tons, valued at \$183,422, according to the United States Geological Survey. This was the largest output in the history of the industry, and an increase of 361 tons in quantity and of \$20,185 in value compared with the production for 1912. The industry was confined to three States—New Hampshire, New York and North Carolina.

Sulphur from Coke Ovens.

Apparatus for the elimination and commercial utilisation of sulphur from the coke ovens of the Semet Solvay Co. are now being installed in Steelton, Pa. This company operates 120 coke ovens there, and the amount of sulphur that is wasted annually from burning soft coal is a large item. It is now planned to separate this sulphur and market it.

The Norwegian Nitrate Industry.

Returns covering the operations of the Norwegian electro-chemical companies during 1913 would indicate that the industry there is now established on a fairly sound basis. The companies operating worked full time throughout the year. The exports of Norwegian saltpetre amounted to 70,171 tons in 1913, as against 51,701 tons in 1912. The exports of nitrate of soda and nitrate of ammonia during 1913 were 17,028 tons, as against 13,480 tons in 1912. The production of calcium cyanamide in 1913 amounted to about 45,000 tons. The Norsk Act. Elektrokemist Industri has announced that its capital will be increased and that products not heretofore manufactured will be made.

Molten Metal Sprayer.

A new apparatus for coating any kind of material with molten metal by directing on it a fine spray has recently come into use in France. According to the *Revue de Metallurgie*, Paris, the machine is called a pistol syringe. The metal in the form of wire is fed automatically into it, and melted by means of an oxyhydrogen flame, or a flame where the hydrogen is replaced by illuminating gas. The molten metal is sprayed with compressed air, which also

works a small turbine that advances the wire. The use of metallic powder is therefore obviated. The most divers metals can be used—lead, tin, zinc, aluminium, brass, copper, etc. The inventor also anticipates a successful use of glass and enamel. Very thin coatings can be produced for purely decorative purposes, or thicker ones that can be polished by ordinary methods, and, if desired, removable coatings several millimetres thick for reproducing medals, plates for engraving, etc.

Substitute for Casein.

A recent number of the *United States Paper Maker* contained a reference to a new substance which has been named Vegesto, and which is claimed to be a useful substitute for casein in manufacturing coated paper. Its value consists in its cheapness of production as well as the reduced mechanical operations necessary to its application, together with the fact that it may be mixed and kept standing without danger of decay. Unlike casein or glue preparations which are at present used in making coated papers, it requires no boiling or steam heating, but may be mixed with cold water and clay, blanc fix and satin white. It dries very quickly, thus reducing the space ordinarily required in drying coated paper, which at present must be festooned for some 150 ft. and dried in a room at a high temperature. A company to exploit the new proposition is now in process of formation.

Liquid Air.

The growth in the production and application of liquid air to engineering projects was demonstrated in a recent lecture before the Société des Ingénieurs Civils de France, where it was stated that the cheap production of oxygen from liquid air has given a great impulse to the new industry. Liquid air, which was first produced by Cailletet in 1877, is now said to be produced at the rate of 3,532 eub. ft. per hour. The process of manufacture consists essentially in allowing air to cool, after compression, by its own expansion, which is then used to cool a further supply of gas which is still to undergo expansion, and so on until liquefaction takes place.

The cost of oxygen obtained in this manner is said to be about 20 francs per ton. With oxygen at such a price it becomes not only possible, but commercially advantageous to use it in many engineering processes, and several interesting applications of the gas were shown at the lecture. Furthermore, it was stated that by the addition of oxygen to the blast in a 100-ton blast furnace of the Ougrée works in Belgium, a saving of 60 kilos. in the coke necessary for smelting one ton of iron ore has been obtained with, in addition, an increased output of 10 to 15%. Thick armour plates can be readily cut through by first heating the metal to a high temperature and directing on to the surface a fine jet of cold oxygen.

Boric Acid in Bleaching.

In a note to the Mulhouse Society, Robert Weiss states that he has found that boric acid is capable of replacing mineral acid in bleaching. A solution of $\frac{1}{2}$ oz. per gallon is strong enough to neutralise caustic soda or carbonate of soda lyes, and is entirely without any tendering action, even when it is dried on the fibre. A much stronger solution has very little action on the usual metals. It can also be used to increase the lustre of certain fibres, ramie, for instance, and it is much better for this purpose than

mineral acids or tartaric, oxalic, lactic, and acetic acid, even at a strength of $\frac{1}{2}$ oz. per gallon in water at about 140° F. It brightens American cotton fabrics almost as well as sulphuric acid in cold water, even when 2 ozs. per gallon of this latter are used.

Textile Materials.

The last annual report of the Prussian Royal Testing Office at Gross-Lichterfelde contained some disparaging remarks on the deterioration of German textile manufactures, which caused a storm of indignation among those concerned. Several chambers of commerce, *e.g.*, the one at Elberfeld-Barmen and the "Aeltesten der Kaufmannschaft of Berlin," raised an angry protest against the undesirable interference of Professor Dr. Martens, the author of the report, and asked other corporations to join the movement of protest. It is argued that any deterioration in quality of German manufactures is simply the consequence of the general rise in raw materials, which force the manufacturers to substitute cheaper materials in order to produce articles at popular prices. The suggestion for the creation of "quality standards" is adversely criticised, as it would throw further difficulties in the path of the manufacturer in meeting the competition of foreign rivals.

Japanese Bean Butter.

In connection with the recent "boom" in nut butter in Europe, it is interesting to note that the Japanese are also consumers of butter and milk produced from vegetables. According to an Eastern journal Japanese manufacturers pay particular attention to pure sorts of bean butter, which possesses the colour of milk. The demand for this kind of bean butter is as great as for that of cow's milk, which it is replacing to a great extent on account of its cheapness and nutritive value. The bean butter does not contain any deleterious substances and is, therefore, recommended for children's and invalids' use.

M. L.

CONSULAR REPORTS.

Russian Copper Industry.

The acting British Vice-Consul at Rostov-on-Don reports that, according to the Bulletin of the "Kharkov Coal and Iron Trade Bourse," progress in the Russian copper industry was maintained in 1913, although not to the same extent as in previous years, the output amounting to 2,095,000 pounds, as compared with 2,017,000 pounds in 1912 and 1,564,000 pounds in 1911. The apparent check in the rate of progress was, however, due to the decrease in the quantity of copper smelted in the Urals, owing to some of the works in that district having been repaired and reconstructed during 1913. The production in the Urals in 1913 amounted to 1,055,000 pounds, as compared with 1,102,000 pounds in 1912, the Caucasus coming next with 611,000 pounds, as compared with 576,000 pounds in 1912. The condition of the copper market is quiet and prices are steady.

Exports of Refined Sugar from Japan.

Japan started a sugar-refining industry on a large scale and hoped, with her high tariff and with the raw sugar which she proposed to grow in Formosa, to be in a position to remove sugar, both raw and refined, completely from the import list. Owing, however, to the typhoons to which Formosa is subject, her aspirations with regard

to raw sugar have not been fulfilled, and enormous quantities have had to be imported from Java; but, as regards refined sugar, not only are imports practically dead, but a large export trade has been developed.

Duty on Acetic Acid, Dextrin, etc., in Uruguay.

A recent issue of the Uruguayan *Diario Oficial* contained a Ministerial resolution, providing that acetic acid, dextrine, and Solvay soda are to be included in the schedule of "Primary materials" contained in the Decree of February 16th, 1913, and are to be dutiable on importation into Uruguay at the rate of 5% *ad valorem*, plus the usual additional duties amounting to 3.65% *ad valorem* (3% for port works, $\frac{1}{2}$ % for consular service, and $1\frac{1}{2}$ per mil. for "patente de giro").

Mineral Deposits in Trebizond.

A consular report on the Turkish vilayet of Trebizond says: There are numerous mineral deposits in the district, both near the coast and in the interior, and it is especially rich in copper. Silver-lead, zinc, iron and manganese ore are also met with. So long as the district remains without railways and roads, mines in the interior have only a problematic value. Local mineowners have generally an exaggerated idea of the value of their properties, and expect to be able to sell straight off for a large lump sum, rather than give an option for a certain period to enable the necessary preliminary work to be done. The possibilities of the district appear to be known to British mining engineers, who are often met with. A British company is carrying on research work at a group of mines near Tireboli. Up to the present most of the mining enterprises in the vilayet seem to have resulted in loss of money.

MARKET REPORTS.

LONDON.—Exports of chemicals, drugs, dyes, and colours have experienced a further considerable reduction of value during the month of June, the total value amounting to £1,550,297, against £1,638,825 during the corresponding period of last year. The most notable decrease occurred in the section for coal products, not dyes, the value of these falling from £209,253 in 1913 to £153,809 last month. Bleaching powder showed a reduction of 4,243 cwts. valued at £1,252 and soda compounds decreased from 627,133 cwts., valued at £152,825, to 547,364 cwts. of a value of £134,727. In contrast with the decline of the exports, the imports of chemical products have to record a further gain over last year, the total value amounting to £1,090,597, a rise of £114,595. This was chiefly due to increased takings of soda and potash compounds, bleaching materials, cream of tartar, calcium carbide, etc. The home trade in chemicals suffers from a seasonable dulness, and the resulting weakness of prices makes buyers even more reluctant to place orders, as nobody likes to buy in a falling market.

Fertilisers proved a very flat section, and the tendency of prices for nitrate of soda favoured buyers. It is true that some Continental sellers have raised their quotations quite recently, but as they were unable to maintain the rise owing to lack of support, the position of the article appears as uncertain as ever. Only a pronounced revival of the demand might prevent further weakness, but there is very little ground for expecting such a phenomenon. The quotation for refined nitrate of soda is £10 17s. 6d., and for ordinary quality £10 10s. A small but perceptible improvement has taken place in sulphate of ammonia, the makers of which

are presenting a firmer attitude. Owing, no doubt, to the decrease in the coke-oven production, the offering has been reduced, causing increased interest for the article on the part of consumers. Gray, 25% quality, is quoted at £10 15s.—£11. The market for tar products has a lifeless and weak appearance, with the exception of creosote, which remain, in good demand at firm prices, *e.g.*, 3½d.—3¾d. per gallon. It is very difficult to define the real position of pitch, which seems to excite a fair amount of interest, without, however, leading to much business. The buyers seem convinced that they should not pay more than 30s. per ton, at which price considerable business could be done, but makers are holding out for 1s. 6d. to 2s. 6d. more, and this difference of opinion is, of course, an obstacle to transactions of any size. The exports of pitch during June fell off in a remarkable manner, amounting to 372,789 cwts. only, compared with 629,650 cwts. in June, 1913, while the value reached £36,444, against £72,014. Benzols are fairly well inquired for, especially for motor purposes, but the increasing German competition makes it difficult to obtain more than 9d.—10d. per gallon for prompt delivery. At present little can be done in solvent naphtha, which is offered at 9d.—9½d. Heavy naphtha is held at 11d.—11½d. in casks. Carbolic acid remains lifeless but steady, and the prices are not likely to go much lower. Crude 60's are held at 1s. 0½d. per gallon. Naphthalene enjoys a regular demand for prompt and distant delivery. Good to fine qualities are obtainable at from 55s. to 95s. per ton.

MANCHESTER.—The prospect of a short time arrangement in Lancashire and the approaching holidays in the cotton trade are two factors which help to restrict business in chemicals for textile purposes. Consumers are naturally anxious to minimise their takings, especially as the prices of some articles are not low enough to be tempting. Bleaching powder is slightly weaker at £5 7s. 6d. soft wood and £5 17s. 6d. hard wood. Green copperas moves slowly at £1 10s., and white powdered arsenic is easier, being nominally quoted at £13 7s. 6d.

LIVERPOOL.—The recent improvement in the chemical market has been maintained, and certain sections have presented quite a lively appearance. The hot weather stimulated the inquiry for compressed carbonic acid, chloride of calcium and anhydrous ammonia for use with refrigerating installations. Sulphate of copper has been bought in fair quantities for shipment to Ireland. The quotation for prompt delivery is £20 to £20 5s. per ton, less 5% in 4 to 6-cwt. casks, f.o.b. Cream of tartar is sparsely offered and firm. Caustic soda, borax, and soda ash (ammonia alkali) have been in good request.

GLASGOW. In consequence of the works closing down for the summer holidays, business has been getting quieter all round. Prices show no alteration.

Metal Markets.

LONDON.—The copper market has assumed a lifeless and neglected appearance, owing to renewed realisations on account of indifferent American reports. Standard copper has been freely offered at £61 for cash and £61 10s. for three months' warrants. The sagging tendency has affected the market for refined and manufactured descriptions. Electrolytic copper has been sold by Continental dealers at £63 2s. 6d., though local sellers asked £63 10s. Consumers are not anxious to place new orders, but the speculative business seems likely to improve on slight stimulation. The statistics covering the first half of July showed a decrease of 500 tons in the European visible supply. Tin has developed fair activity, but the large local stocks, which amounted last

week to 2,753 tons, checked the speculative element. The quotation for three months' metal went down to £144 15s. The general demand for lead has fallen off, consumers being evidently not badly in need of supplies. The Mexican situation appears more hopeful and arrivals have been rather plentiful of late. English lead is now obtainable at £19 10s. and foreign at £18 10s. The inquiry for spelter is very fair. In view of the slowly decreasing stocks, an advance in prices is not unlikely. The Syndicate still quotes £21 12s. 6d. The demand for zinc sheets remains fairly satisfactory. Makers of galvanised sheets maintain their quotations.

FINANCIAL ITEMS.

The English Velvet and Cord Dyers, Ltd., have declared an interim dividend of 3% on the ordinary shares.

The Rosario Nitrate Co., Ltd., have resolved to pay an interim dividend for the last year of 7½% free of income tax.

The Normanby Ironworks Co., Ltd., propose paying an interim dividend of 3%, making 6% for the year.

The Gas Light and Coke Company have declared a dividend at the rate of £4 17s. 6d. per annum for the last half year; this is the same as last year.

Tarmac, Ltd., has declared a dividend of 10% free of income tax, for the half year ending June 30th.

The Mond Nickel Co., Ltd., have still further consolidated their position by securing further mines and property in Canada, and have spent further large sums in the construction of smelting furnaces. In order to arrange a reorganisation of capital, the present company will be liquidated.

Boots Pure Drug Co., Ltd., are issuing 150,000 7% "D" preferred shares of £1 each at 4s. 6d. premium.

Gesellschaft der Tentelewschen Chemischen Fabrik, St. Petersburg, increased their sales and output during the last year, but in consequence of high costs for raw materials, fuel, etc., the net profits were reduced from 345,855 roubles in 1912 to 286,045 roubles in 1913. The dividend has, therefore, been decreased from 10% to 8%. The prospects for the current year appear excellent, though the scarcity of workmen may lead to higher wages.

The International Kunstseidenindustrie Gesellschaft "Gallia" has been incorporated with a capital of 2,500,000 francs to exploit new patents for the manufacture of artificial silk.

CONTINENTAL NOTES.

The annual report of the German Chamber of Commerce on the trade in gelatine and glue in 1913 states that the general conditions of the industry were fairly satisfactory, but the much-needed increase of prices could not be carried through uniformly. The sales were large, but carried inadequate profits. The German exports to Austria-Hungary have been further reduced, whereas the imports from this country are still at the head of the import list.

From Redcliff, Alberta, the new Canadian manufacturing town in Medicine Hat district, the discovery of a rich deposit of silica sands only two miles outside the town is reported. Up to the present this sand has been imported by manufacturers from Iowa.

GUX COTTON EXPLOSION IN GERMANY.—At Düren, in the Rhine province, an accident occurred through the inadvertent firing of a cartridge in a gun-cotton factory.

Two explosions shook the whole town, and thousands of window panes were smashed and roofs blown off. The greater part of the factory collapsed, and twenty persons were injured.

KISSARMAS.—A syndicate of German and Belgium financiers has been formed for the purpose of exploiting certain ore deposits which have recently been discovered at Jadvölgy (Bihar). These deposits will be worked for the purpose of producing aluminium. The company has a capital of 10,000,000 kr.

PRESSBURG (Hungary).—A company has been incorporated under the style of "Magyar grafit és banya r.t." (Hungarian Plumbago and Mining Co., Ltd.) for the purpose of graphite production. Capital, 650,000 kr., in shares of 100 kr. each.

NEW CEMENT FACTORY IN NORWAY.—A Portland cement factory is about to be erected at Gjällebäk, in Lier, Norway, where the natural conditions are considered very favourable. The factory will be located some five to six miles from the place where the raw materials are found, and will have good accommodation for shipment. The raw material will be conveyed to the factory by means of a rope line. The minimum annual output has been put at 200,000 barrels, in addition to which it is proposed to sell some 15,000 tons of limestone per annum. The capital amounts to 2,000,000 kr.

TRADE ITEMS.

E. Merck (Darmstadt), through their London branch at 66, Crutched Friars, E.C., issue an immediate delivery list of pharmaceutical, analytical, and technical chemicals, and the packages they are made up in. This list has been recently revised and extended.

The Cambridge Scientific Instrument Co., Ltd., issue particulars of their new recording densimeter, which should be of considerable value to those who have to deal with volumes of solutions which have to be kept at constant strength, such, for instance, as a solution of sulphurous acid prepared from the product of sulphur burners.

NEW COMPANIES.

COX BROTHERS & CO. (DERBY) LTD.—Capital, £50,000, in £1 shares (15,000 6% Cumulative Preference). Objects: To take over the business carried on by A. Cox and Miss E. C. Cox at Mill Hill and the Morledge, Derby, and at Nottingham and elsewhere, as Cox Brothers & Co., and to carry on the business of manufacturers of and dealers in lead, lead products, etc. Registered office: Mill Hill, Derby.

ENGLISH AND SCOTTISH MORTGAGE AND POMEROY'S "MOA" WATER SOFTENER, LTD.—Capital, £2,000. Object: To take over all or part of the right and interest in an invention for an apparatus for softening and removing impurities from water fed into steam boilers and the like. Private company.

THOMSON, WATSON & CO., LTD.—Capital, £1,000. Object: To carry on the business of chemists, drysalers, oil and colour men, etc. Registered office: 133, St. Vincent Street, Glasgow.

KYROZITE SYNDICATE, LTD.—Capital, £2,000 in £1 shares. Object: To take over any invention relating to the production, application, manufacture, distribution, and use of a certain material known as "Kyrozone," a substitute for celluloid, ivory, vegetable ivory, bone, horn, ebony and similar materials, in particular to acquire from H. B. P. Humphries and R. Dodd an option for a free and

exclusive licence over the English patent, granted or to be granted to them, and certain rights in connection with any foreign patents in respect thereof. Registered office: 36, Basinghall Street, E.C.

TODRICK, TAPP & CO., LTD.—Capital, £3,000. Object: To carry on the business of indiarubber, asbestos and general merchants. Private company.

COAL DISTILLERS, LTD.—Capital, £7,850. Objects: To take over a licence from Oil and Carbon Products, Ltd., and to work certain inventions for the treatment of coal on any other substance or their residuals or by-products, and to adopt an agreement with W. W. White. Registered office: 124, Chancery Lane, W.C.

VINCENTS, LTD.—Capital, £1,000. Object: To carry on the business of pharmacists, chemists, druggists, manufacturers of and dealers in chemical preparations, etc. Registered office: 106, Fulham Road, S.W.

SHARE LIST.

Name of Company.	July 24th.	June 24th.
Alby United Carbide	1 ¹³ / ₃₂ 1 ¹⁷ / ₃₂	1 ¹⁵ / ₃₂ 1 ¹⁹ / ₃₂
Ditto. Pref.	1 ¹ / ₁₆ 1 ¹ / ₁₆	1 ¹ / ₁₆ 1 ¹ / ₁₆
Associated Portland Cement. (10)	5 ⁵ / ₈ 5 ⁵ / ₈	5 ⁵ / ₈ 5 ⁵ / ₈
Ditto. Pref. (10)	8 ¹ / ₂ 8 ¹ / ₂	8 ¹ / ₂ 8 ¹ / ₂
Babcock-Wilcox. Ord. ..	2 ¹³ / ₁₆ 2 ¹⁵ / ₁₆	2 ¹³ / ₁₆ 3
Ditto. Pref.	1 ¹⁵ / ₁₆ 1 ¹⁷ / ₁₆	1 ¹¹ / ₁₆ 1 ¹³ / ₁₆
Bell's United Asbestos	1 ⁹ / ₁₆ 1 ¹³ / ₁₆	1 ⁹ / ₁₆ 1 ¹³ / ₁₆
Bleachers' Association. Ord. ..	1 ¹ / ₁₆ 1 ¹ / ₁₆	1 ¹ / ₁₆ 1 ¹ / ₁₆
Ditto. Pref.	1 ¹ / ₃₂ 1 ¹ / ₃₂	1 ¹ / ₃₂ 1 ¹ / ₃₂
Borax Consolidated. Pfd. (5) ..	5 ⁵ / ₈ 5 ⁵ / ₈	5 ⁵ / ₈ 5 ⁵ / ₈
Ditto. Defd.	1 ¹³ / ₁₆ 1 ¹⁵ / ₁₆	1 ¹³ / ₁₆ 2
Ditto. Pref. (10)	11 ¹ / ₂ 12 ¹ / ₂	11 ¹ / ₂ 12
Bradford Dyers	1 ¹ / ₁₆ 1 ¹ / ₁₆	1 ¹ / ₁₆ 1 ¹ / ₁₆
Ditto. Pref.	1 ¹ / ₃₂ 1 ¹ / ₃₂	1 ¹ / ₁₆ 1 ¹ / ₁₆
British Oil and Cake. Ord. ..	4 ¹ / ₂ 4 ¹ / ₂	4 ¹ / ₂ 4 ¹ / ₂
Brunner Mond. Ord.	14 ¹ / ₂ 15	14 ¹ / ₂ 15
Ditto. 7% Pref. (10) ..	2 ¹ / ₂ 2 ¹ / ₂	2 ¹ / ₂ 2 ¹ / ₂
Bryant and May. Pref.	2 ¹ / ₂ 2 ¹ / ₂	2 ¹ / ₂ 2 ¹ / ₂
Calico Printers	3 ¹ / ₂ 3 ¹ / ₂	3 ¹ / ₂ 3 ¹ / ₂
Ditto. Pref.	3 ¹ / ₂ 3 ¹ / ₂	3 ¹ / ₂ 3 ¹ / ₂
Castner Kellner	2 ⁷ / ₁₆ 2 ⁹ / ₁₆	2 ⁷ / ₁₆ 2 ⁸ / ₁₆
Commercial Salt. (2/-)	6 ¹ / ₂ 7 ¹ / ₂	6 ¹ / ₂ 7 ¹ / ₂
Crossley & Sons. (2)	1 ¹ / ₁₆ 1 ¹ / ₁₆	1 ¹ / ₁₆ 1 ¹ / ₁₆
Ditto. 5% Pref.	4 ³ / ₈ 4 ³ / ₈	4 ³ / ₈ 4 ³ / ₈
Eastman Kodak. (\$100) ..	550 600	525 575
Eley Brothers	1 ¹ / ₂ 1 ¹ / ₂	1 ¹ / ₂ 1 ¹ / ₂
Fraser and Chalmers. (£3) ..	1 ¹ / ₂ 1 ¹ / ₂	1 ¹ / ₂ 1 ¹ / ₂
Gas Light and Coke. (S) ..	103 105	101 103
Ditto. 4% Pref. (S)	96 99	96 99
Greenwich Lino. (½)	1 ¹ / ₁₆ 1 ¹ / ₁₆	1 ¹ / ₁₆ 1 ¹ / ₁₆
Harrison and Crossfield. Pref. ..	1 ¹ / ₁₆ 1 ¹ / ₁₆ xd.	1 ¹ / ₁₆ 1 ¹ / ₁₆
Imperial Continental. (S) ..	163 168	161 166
Ditto. 3½% Debenture (S) ..	84 86	84 86
India Rubber Co. (10)	9 10	9 ³ / ₄ 10 ³ / ₄
International Salt	3/3 4/3	3/3 4/3
Ditto. Pref. (5/6 pd.) ..	1 ¹ / ₂ 1 ¹ / ₂	1 ¹ / ₂ 1 ¹ / ₂
Lever Brothers. 1st Pref. (10) ..	11 ¹ / ₂ 11 ¹ / ₂	11 ¹ / ₂ 11 ¹ / ₂
Ditto. "C" Pref.	1 ¹ / ₁₆ 1 ¹ / ₁₆	— —
Lister & Co. Ord.	1 ¹ / ₁₆ 1 ¹ / ₁₆ xd.	1 ¹ / ₁₆ 1 ¹ / ₁₆
Mappin & Webb. Ord.	1 ¹ / ₁₆ 1 ¹ / ₁₆	1 ¹ / ₁₆ 1 ¹ / ₁₆
Neuchâtel' Asphalt.	9 ³ / ₄ 10 ¹ / ₄	9 ³ / ₄ 9 ³ / ₄
Nobel Dynamite. (10)	15 ¹ / ₂ 16 ¹ / ₂	15 ¹ / ₂ 16 ¹ / ₂
Ditto. Bearer (10)	15 ¹ / ₂ 16 ¹ / ₂	16 16 ¹ / ₂
Ditto. 5% Pref. (10)	11 12	11 12
Pears, A. and F. Ord.	1 ¹ / ₁₆ 2 ¹ / ₁₆	1 ¹ / ₁₆ 1 ¹ / ₁₆
Ditto. 6% Pref. (10)	12 ¹ / ₂ 12 ¹ / ₂	12 ¹ / ₂ 12 ¹ / ₂
Price's Candle. (16)	36 ¹ / ₂ 38 ¹ / ₂	36 ¹ / ₂ 38 ¹ / ₂
Rosario (5)	8 ⁵ / ₈ 8 ⁵ / ₈	8 ⁵ / ₈ 8 ⁵ / ₈
Salt Union. (4)	1 ¹ / ₈ 1 ¹ / ₈	1 ¹ / ₈ 1 ¹ / ₈
South Metropolitan 4% Stand-	111 113	109 111
dard (S)	72 ¹ / ₂ 74 ¹ / ₂ xd.	74 76
Ditto. 3% Debenture (S) ..	4 ¹ / ₂ 4 ¹ / ₂	4 ¹ / ₂ 4 ¹ / ₂
United Alkali. (10)	5 ¹ / ₂ 6 ¹ / ₂	5 ¹ / ₂ 6 ¹ / ₂
Ditto. Pref. (10)	1 ¹ / ₃₂ 1 ¹ / ₃₂	1 ¹ / ₃₂ 1 ¹ / ₃₂
Val de Travers	1 ¹ / ₃₂ 1 ¹ / ₃₂	1 ¹ / ₃₂ 1 ¹ / ₃₂



THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY W. P. DREAPER, F.I.C.

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

VOL. III. No. 9.

SEPTEMBER, 1914.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
" " Abroad 8s. " "

The Alkali Trade.

THE fifteenth annual report of Alkali, etc., Works for the year 1913 indicates that the number of existing alkali works was 1,327, including 70 in which salt was decomposed with evolution of hydrochloric acid. There was, therefore, a decrease of three in the number registered as alkali works but an increase of 25 in works otherwise registered, making a net increase of 22 as compared with 1912. There were also 167 works registered in Scotland, making in all an aggregate of 1,494 for the United Kingdom. In many of these works more than one registered process was carried on.

From the table illustrating the actual processes in action, under the heading of salt cake 48 are registered, cement 60, against 55 last year; smelting 75, against 72 in 1912 and 76 in 1911; sulphuric acid (Class I. and II.) 236, against 235 in 1912 and 238 in 1911. The chemical manure works number 155, as compared with 158 in 1912, but nitric acid shows 72, against 73 in 1912 and 61 in 1911. Chlorine shows a still further decrease, being 27 for 1913, 28 in 1912, and 30 in 1911. The figures for tar are 192, against 179 in 1912 and 163 in 1911.

The actual increase in processes of 54, as compared with 1912, is again largely associated with the utilisation of by-products, the sulphate of ammonia and tar works being responsible for one-half of the aggregate increase observed.

The inspectors paid 6,107 visits to works and made 6,344 tests. In addition, numerous visits were made to works which did not come under the Act in connection with complaints of injury from noxious gases, the disposal of acid, etc., provided for under section 3 of the Act.

The average escape of acid gases from the different districts varied greatly, but the general averages for the whole country vary but slightly from the previous year. The substitution of mechanical for hand operation of manufacturing plant is stated to have greatly improved things where the escape of acid gases or fumes was incidental to the latter.

The adoption of mechanical furnaces for calcining burned pyrites in copper works was considerably extended during the year, with satisfactory results

alike as regards quality of product, efficiency of condensation of acid gases, and the avoidance of escape of fumes from the furnace during the removal of the finished product.

In the same way the continued replacement of rotary furnaces in cement production has led to better conditions, except in one case, where the cause of offence was not limited to the kiln, but arose from other operations carried on in the works. The vertical kiln, both intermittent and continuous, is gradually giving way to the horizontal continuous rotary kilns.

In sulphuric acid works (Class II., catalytic) it is recorded that "silica ware, 'tantiron' and, to a small extent, 'ironac' were in use as materials for evaporating vessels."

Once more the report is a model one, Mr. Linder's important researches are continued and recorded in connection with the behaviour of oxide of iron during fouling and revivication.

NOTES ON RECENT THEORY AND PRACTICE.

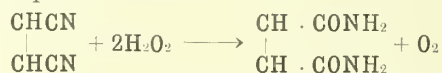
BY HERBERT H. HODGSON, M.A., B.Sc., PH.D.

The interaction of sodium amalgam and water forms the subject of an interesting paper by Baker and Parker (*Chem. Soc. Trans.*, 1913, 2060—2073). Two years ago Baker had observed that water prepared under special conditions, acted with a strikingly slower velocity on sodium amalgam than did ordinary distilled water, and the explanation of this activity is now shown to be probably due to the presence of traces of hydrogen peroxide. Addition of the latter increases the activity enormously and, where colour tests have shown the presence of hydrogen peroxide, that specimen of water has been shown to be more active than where the test has not been delicate enough to detect it. All the very inactive specimens of water were prepared under conditions favourable to the decomposition of hydrogen peroxide, e.g., the superheating of the steam in a copper condenser and the distillation from a platinum apparatus. This explanation also accounts for the fact that the activity of water is no function of its

conductivity, as it has been demonstrated that the addition of a small quantity of hydrogen peroxide to a sample of water, whilst increasing its activity very much, did not appreciably alter its conductivity.

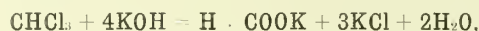
A study of the interaction of glycerol and oxalic acid by F. D. Chattaway (*Chem. Soc. Trans.*, 1914, 105, 151—156), has afforded results which show that the explanation usually given in the text-book for the mechanism of this reaction is incorrect. Oxalic acid forms both a normal and an acid oxalate with glycerol, and the latter oxalate readily decomposes at a slightly elevated temperature into carbon dioxide and monoformin. Fresh oxalic acid displaces formic acid from the monoformin, and the cycle of operations is repeated. This is shown by the fact that, on adding ammonia or aniline to the reaction mixture, oxamic or oxanilic acids can be obtained, demonstrating the existence of the acid glyceryl oxalate in the melt. Using ethyl alcohol in place of glycerol, the whole series of reactions were carried out and the products isolated at every stage. The allyl alcohol obtained when the reaction mixture is rapidly heated to a higher temperature, results from the decomposition of the normal glyceryl ester, dioxalin.

Keiser and McMaster have dealt with the previous difficulty of converting fumaric nitrite into fumaric acid (*Ber.*, 181, 355). They express the opinion that the former difficulty was no doubt due to the fact that the quantities worked with were small, and having succeeded in preparing the nitrate in larger quantities, its ready conversion was accomplished by means of an alkaline solution of hydrogen peroxide—



In the domain of analysis, Stewart and Greaves have conducted an important investigation into the influence of chlorine on the determination of nitrates by the phenol disulphonic acid method (*Chem. News*, August, p. 97). The question involved is of fundamental importance for the determination of nitrates in the cultivated soils of the arid west, which may be impregnated with alkali. The authors have previously (*Journ. Amer. Chem. Soc.*, 1910, 32, 756) demonstrated the marked influence of chlorine upon the amounts of nitrates determined, and found that if the soil solution contained even as low a concentration as 2.6 parts per million of chlorine in the soil extract, less nitrates were found by this method than were actually present. When only 0.1 mg. NaCl was to hand, all the nitrates could be easily determined, but Lipman and Sharp have found (*Univ. of Cal. Publication in Agr. Sci.*, 1912, 1, 12) that when 0.25 mg. NaCl occur, only 90% of the nitrates present could be estimated and with a concentration of 1 mg. the amount dropped to 70%. The net result of both investigations is that ionic chlorine has a marked influence on the determination of nitrates in the soil extract, and that in alkali soils this fact must be taken into consideration in determining the nitrate content. There is another phase of the question, however, which Stewart and Greaves

believe to have been passed over by previous investigators, and this is the influence of chlorine which is not in ionic form but combined in the organic molecule. This is a question of considerable practical importance, since chloroform is frequently used to inhibit the action of bacteria in the soil extract. This is particularly the case in the lime method proposed by Lipman and Sharp, since, if chloroform be also present, there is the possibility of the formation of ionic chlorine from the organic chlorine of the chloroform, which if there in sufficient quantity would materially affect the results obtained. This assumption would appear to be justified by the action of lime on chloroform, since caustic potash acts as follows—



with the production of ionic chlorine, and the same reaction was established experimentally for lime and chloroform, the quantity of chlorine varying with the chloroform. The marked influence of chlorine on the nitric nitrate in the soil nitrogen as distinct from that on the determination of nitrates in solution was also demonstrated. Stewart and Greaves conclude that when chloroform is not used, the lime method is highly desirable for soils rich in nitrates and organic matter, since it provides a clear solution and offers no obstacle to the determination of the nitrates.

The preparation of pure dimethyl-o-toluidine by Braun and Anst (*Ber.*, 1914, 47, 260—262) is an interesting example of the uses to which formaldehyde is being submitted. To obtain the dimethyl-o-toluidine from its accompanying impurities, viz., the para-isomeride, dimethyl-m-toluidine, and dimethylaniline, recourse is had to treatment with formaldehyde and hydrochloric acid on the water-bath. The mixture is afterwards rendered alkaline, washed, and fractionated *in vacuo*. Dimethyl-o-toluidine is almost entirely unacted upon, while the impurities are converted into products of very high boiling point.

The Chem. Fabr. vorm. Weiler-ter Meer have patented an instructive process involving the use of hydrogen carriers for the continuous reduction of nitro-compounds (Fr. Pat. 462006. August 29th, 1913). Ferrous oxide and magnetic iron oxide are found to be excellent hydrogen carriers for this purpose, and especially so in the case of nitrobenzene. The nitro-compound is mixed in a state of vapour with hydrogen, or a gas containing hydrogen, and the mixture then passed over finely divided and heated ferrous oxide or magnetic oxide, which it is advisable to mix with an indifferent substance, such as asbestos or kieselguhr. The iron oxides are not reduced during the process.

The use of carbon bisulphide as a laboratory solvent should be made with caution after noting the results obtained by Vlies (*J. Soc. Dyers and Col.*, 1906, 65), who finds that, even when carefully purified by treatment with bromine, permanganate and fuming nitric acid, that a deposit is left behind when the carbon bisulphide is boiled for a long time in a Soxhlet apparatus.

THE DISCOVERY OF OXYGEN.

By PROFESSOR J. B. COHEN, B.Sc., Ph.D., F.R.S.

It is not my intention to revive the old question of Lavoisier's share in the discovery of oxygen. We know that it was first prepared and fully described by Scheele in 1773, and obtained independently by Priestley in the following year. My object is rather to dispel the fog of prejudice and ignorance which, strange to say, still surrounds the subject, and to modify the harsh judgment that certain historians of chemistry have passed on Lavoisier for considering himself a co-discoverer of oxygen. I have been induced to do this by reading in a recently published volume on chemistry¹ the following statement: Referring to Lavoisier as one of the giants of science, the author says: "But giants have their weaknesses, and Lavoisier's failing was that he largely ignored the work of others and was inclined to take the credit of their discoveries to himself," and proceeds to make the amazing statements that "he never mentions the theories of Rey, Hooke and Mayow on combustion so closely approximating his own, though he must have known them. Again Priestley told him, during a visit he paid to Paris, of his discoveries of oxygen. He ignored Black's work on carbonic anhydride and also to a considerable extent Cavendish's classic researches on the composition of water." This notion that Rey, Hooke and Mayow anticipated Lavoisier has been repeatedly put forward by writers on chemistry. Sir Edward Thorpe, in his essay "La Révolution Chimique," says that, "Hooke in the *Micrographia* and Mayow in his *Opera Omnia Medicophysica* indicated that combustion consists in the union of something with the body which is being burnt, and Mayow, both by experiment and inference, demonstrated in the clearest way the analogy between respiration and combustion, and showed that in both processes one constituent only of the air was concerned. He distinctly stated that not only is there increase of weight attending the calcination of metals, but that this increase is due to the absorption of the same spiritus from the air that is necessary to respiration and combustion."

Before proceeding it may be as well to examine briefly the theories of these three observers, Rey, Hooke and Mayow. Rey's theory had reference to calcination only. He imagined that the action of heat on air was to distil off the more volatile and lighter portions, leaving the denser mixed with the metal giving rise to the calx, and he compared the definite increase in weights to the moistening of sand with water. The excess of water may be drained away; but not all, as a certain amount will still adhere to the sand. Hooke's theory had reference only to combustion. The combustible disappeared owing to the solvent action of the surrounding air, which dissolved the substance in much

the same way that water dissolves a salt. Calcination is not included and, of course, Hooke's theory could not explain it. There is no doubt that of the three Mayow's view approaches most closely to the modern doctrine, for it includes both combustion and calcination, and explains them by the aid of the same nitro-aerial particles.² It is to be hoped that the translation of the *Tractatus Quinque* recently issued by the Alembic Club will help to throw a clearer light on Mayow's real views, and enable chemists to form their own judgment of them, rather than accept the more or less distorted interpretation devised by other people. Briefly, Mayow's nitro-aerial particles were made to explain nearly every chemical phenomenon; heat or fire, the oxidation of pyrites, and the formation of acids, the tempering of steel, fermentation, the natural production of nitre, the heat of neutralisation and, lastly, calcination, combustion and respiration. Consequently, these nitro-aerial particles had quite a variety of attributes which enabled them to serve almost any desired purpose. Thus, they gave rigidity to matter. When steel was heated and rapidly cooled, the nitro-aerial particles of the fire passed into and were locked up in the metal and made it hard; on slowly cooling they escaped and the steel was soft. These nitro-aerial particles were also present in the air and gave it rigidity. During combustion they were destroyed, the air particles lost their rigidity and contracted. In this way the decrease in volume of air was explained when a candle, and a piece of camphor were burnt, or a mouse was placed in a confined space. The increase of weight of antimony on calcination by a burning glass was caused by the absorption of the nitro-aerial particles, not from the air, however, but from the sun, which was regarded as a "chaos" of these particles, and so on. Before leaving the subject, I should like to quote a paragraph from Professor Crum-Brown's Harveian oration for 1899 on John Mayow. "Rightly or wrongly," he says, "we regard as scientific heroes those and those only who have contributed in an important way to our knowledge or to our understanding of nature. Now, Mayow might have done this, but for reasons, which we shall consider presently, he did not" Then, after discussing his views, he goes on: "All this, which, I think, I may without disrespect to Mayow, call nonsense, is inextricably mixed up with the description of his ingenious and well-contrived experiments and with his clear-sighted interpretation of them, so that we cannot tell which is which, except by comparing his statements with what we now know to be true. A wise man once said to me,

² It is frequently stated that Mayow's views and experiments were entirely lost sight of until they were revived subsequently to Lavoisier's new doctrine. This is not strictly true, as they are mentioned in some detail in Hales' "Vegetable Statics," published in 1731, a book widely known among contemporary scientists.

¹ "Some Fundamental Problems in Chemistry Old and New," by E. A. Letts, 1914.

speaking of a friend who had just left us: 'Our friend has a great deal of knowledge, more than we have, on all sorts of subjects, but his knowledge is so mixed up with his ignorance as to be of very little use: the separation of the light from the darkness was as necessary a work as the creation of the light.'"

It is hoped that in the future we shall hear less of Mayow as the forerunner of Lavoisier, however much interest his work may deservedly continue to inspire in students of chemical history.

Let us now consider for a moment Professor Lett's accusation, that Lavoisier's failing was that he largely ignored the work of others and was inclined to take credit of their discoveries to himself, that he never mentions the theory of Rey, and ignored Black's work on carbonic anhydride. My reason for referring to this is that, owing to the tone which has been adopted by certain writers, and which others have assimilated without taking the trouble to examine original documents, the opinion is very prevalent that Lavoisier played the part of a scientific vulture constantly scenting out and preying on the discoveries of others and carrying them off as his own property. Nothing could be further from the truth. Indeed, it is the very reverse of the truth for, in general, Lavoisier was scrupulous in recognizing the help and assistance he received at the hands of others, and especially of the English chemists, to whom he frequently acknowledged his indebtedness, and for whom he expressed his profound admiration.

In a letter accompanying his "Opuscules physiques et chimiques," which was sent to the Royal Society, he writes: "Je vous prie de recevoir un traité dont le fonds vous appartient en partie et auquel je n'ai fait qu'ajouter un petit nombre de vérités que je crois neuves. C'est à Messieurs Boyle, Hales et Black, noms à jamais célèbres dans les faits de la physique et de la chimie, que la doctrine de la fixation de l'air doit son origine."

It seems almost absurd to remind any serious student of chemical history, who has taken the trouble to casually turn over the pages of "Les Œuvres de Lavoisier" of facts such as these.

But let us examine the specific charges brought by Professor Lett's of ignoring the work of Rey, Black and others of his predecessors. In his great work just referred to, "Opuscules physiques et chimiques," Lavoisier begins by giving a *résumé* of previous work in which Black's name recurs six times. In the following memoir on the increase in weight of metals on calcination he carefully considers the work of Rey, whose name is mentioned eight times, whilst Boyle is referred to twice, Stahl five times, and Hales once, in reference to a repetition of his experiment on the reduction of litharge in a closed vessel. In the next paper on the calcination of tin in closed vessels, which was practically a repetition of Boyle's experiment, so far from ignoring Boyle, he refers to him five times. Without enlarging at too great length on this theme, Lavoisier's frank and generous acknowledgement of the work of others may be illustrated by one more reference, which occurs in the memoir on nitric acid. "Je

commencerais, avant d'entrer en matière par prévenir le public qu'une partie des expériences contenues dans ce mémoire ne m'appartient point en propre, peut-être même, rigoureusement parlant, n'en est-il aucune dont M. Priestley ne puisse réclamer la première idée, mais comme les mêmes faits nous ont conduits à des conséquences diamétralement opposées j'espère que si on me reproche d'avoir emprunté des preuves des ouvrages de ce célèbre physicien on ne me contestera pas au moins la propriété des conséquences."

If anyone wishes to convince himself of Lavoisier's attitude towards the work accomplished by others let him spend half an hour in turning over the pages of his "Œuvres" published under the authority of the French Minister of Public Instruction, and he will find mention of names of distinguished contemporaries and predecessors on almost every page.

Let us now return to Lavoisier's claim, which is contained in the incriminating clause¹: "This species of air was discovered almost at the same time by Dr. Priestley, Mr. Scheele and myself." It will be observed that Lavoisier does not set himself up to be the sole but merely an independent discoverer. We have first to inquire into what constitutes a discovery, a question not always easy to answer, and peculiarly difficult in the present case.

Was the discoverer the man who first prepared the gas, or the one who discovered certain of its properties without recognising its real nature, or, finally, he who first realised its true character and its rôle in combustion and calcination?

We have a simpler, though similar, example in that of helium. Was it Hillebrandt or Miers or Ramsay who is to be regarded as the real discoverer? There is little difficulty in answering this question.

Hales had long before the date of Priestley's discovery heated red lead and noticed the evolution of considerable quantities of gas.² In his "Vegetable Statics," Vol. I., p. 288, he writes: "And that the sulphureous and aerial particles of the fire are lodged in many of those bodies which it acts upon and thereby considerably augments their weight is very evident in minium or red lead, which is observed to increase about $\frac{1}{20}$ part in undergoing the action of the fire . . . and that there is good store of air added to the minium I found by distilling first 1,922 grains of lead, from whence I obtained only seven cubick inches of air; but from 1,922 grains which is a cubic inch of red lead, there arose in the like space of time 34 cubick inches of air." That air must, of course, have been oxygen. Bayen, in April, 1774, heated precipitate *per se* (red oxide of mercury), and also obtained a gas. But neither Hales nor Bayen examined the properties of the air evolved, and no one, therefore, can for a moment regard them as discoverers of a new kind of gas, though the importance of the observation cannot be underrated.

Let us now turn for a moment to Priestley's record of his experiments on oxygen, Vol. I., p. 192.

¹ "Elements of Chemistry," by Lavoisier, translated by R. Kerr, Vol. I., p. 84.

² "Vegetable Statics," by Stephen Hales, 1731.

He there states "that the calces of the metals contain air of some kind or other and that this air contributes to the additional weight of the calces above that of the metals from which they are made had been observed by Dr. Hales." He then proposed to wait to repeat Dr. Hales' experiment until the fine weather set in and he could procure a good burning glass. In the meantime he tried the action of the electric spark on red lead, the idea being to revivify the calx by means of the phlogiston of the electric spark (the latter being found to phlogisticate the air), and obtained a considerable quantity of air. From the observation that this air was absorbed by water like fixed air (carbon dioxide), Priestley concluded that the gas evolved from red lead, was fixed air (carbon dioxide). This view agreed with Priestley's theory (and may also have influenced his observation) that the phlogistication of air, when a metal is converted into calx, was due to the separation from common air of the fixed air which united with the metal to form the calx (Vol. I., p. 187).¹ Immediately following this paragraph Priestley states: "After this I found that M. Lavoisier had completely discovered the same thing, though his apparatus being more complex and less accurate than mine, he concluded that more of the air discharged from the calces of metals was immiscible with water than I found it to be. It appeared to me that I had never obtained fixed air more pure." What Lavoisier's actual experiment was I have not been able to trace; but the fact is an interesting one, for it brings out two points, firstly, that Lavoisier had previous to this been experimenting with red lead and, secondly, that the air obtained by him differed from fixed air by not being so readily absorbed by water. Lavoisier, therefore, must have unconsciously prepared oxygen.

The next event to be noticed is Priestley's visit to Lavoisier in October, 1774. On August 1st of that year Priestley, having obtained a good burning glass, had "endeavoured to extract air from *mercurius calcinatus per se*, and I presently found that, by means of this lens, air was expelled from it very readily. Having got about three or four times as much as the bulk of my materials, I admitted water to it and found that it was not imbibed by it. But what surprised me more than I can well express was that a candle burned in this air with a remarkably vigorous flame very much like that enlarged flame with which a candle burns in nitrous air (*nitric oxide*), exposed to iron or liver of sulphur (*nitrous oxide*), but as I had got nothing like this remarkable appearance from any kind of air besides this particular modification of nitrous air and I knew no nitrous acid (*nitric acid*) was used in the preparation of *mercurius calcinatus*, I was utterly at a loss how to account for it." He then obtained the gas from common red precipitate, in the preparation of which nitric acid was used. He then goes on: "I entertained some suspicion that the *mercurius calcinatus* on which I had made my experiments,

being bought at a common apothecary's, might, in fact, be nothing more than red precipitate, though, had I been anything of a practical chemist, I could not have entertained any such suspicion. However, mentioning this suspicion to Mr. Warltire, he furnished me with some that he had kept for a specimen of the preparation and which he told me he could warrant to be genuine. This being treated in the same manner as the former, only by a longer continuance of heat, I extracted much more air from it than from the other." He afterwards obtained the same kind of air, together with some fixed air, from red lead.

At this point then Priestley had obtained air in which a candle burned more brightly than in common air; but, as he states later, he did not suspect that "the air which I had got from *mercurius calcinatus* was even wholesome, so far was I from knowing what it was that I had really found, taking it for granted, that it was nothing more than such kind of air as I had brought nitrous air (*nitric oxide*) to be by the processes above mentioned, and in this air (*nitrous oxide*) I have observed that a candle would burn sometimes quite naturally and sometimes with a beautiful enlarged flame and yet remain perfectly noxious."

It was not, in fact, until he took up his experiments again in the following March that he convinced himself of the fact that he had discovered a new kind of air.

It is important to realise this, seeing that it was in entire ignorance of the true nature of the air that, in October, 1774, Priestley visited Lavoisier and communicated his observations to the French chemist.

Here was undoubtedly a novel and interesting observation; but does it actually amount to the discovery of oxygen? A peculiar and striking property of this air had been noticed, but it was not yet recognised as a new kind of gas.

And now we must inquire for a moment into what Lavoisier was doing before and during the intervening months which passed before Priestley took up his experiments again.

It was in 1773 that Lavoisier had answered, up to a certain point, the question as to the cause of the increase of weight of the metals and also of sulphur and phosphorus on calcination. It was due to the fixation of air. These results were embodied in his "Opuscles physiques et chimiques." In this memoir no mention is made of the kind of air which combines with the substances; but there is no doubt that Lavoisier thought it was carbon dioxide. The first experiments on the nature of the gas combined in the calces were apparently begun early in 1774, when he heated iron oxide with a burning glass in a bell jar over mercury; but the results were unsatisfactory and the experiments were discontinued. From the statement made by Priestley, and already referred to, Lavoisier must also have been experimenting with red lead at this time or previously. In October he learnt from Priestley of the remarkable properties of the air obtained from red lead and precipitate *per se*, and in the following

¹ Priestley regarded common air as containing fixed air in combination, which was liberated during the combustion of carbonaceous matter and absorbed by the metal on calcination.

month joined his friend Trudaine at Montigny, where they began experiments using precipitate *per se* and red lead, experiments which were clearly based on the information communicated by Priestley.

By Easter, 1775, almost at the very moment when Priestley had satisfied himself as to the nature of the new gas, Lavoisier had completed and read his memoir, in which the properties of the new gas are fully described and the whole phenomenon of combustion and calcination accurately and fully explained. Moreover, Lavoisier had determined the nature of common air and distinguished it from fixed air (*carbon dioxide*), which he now recognised as a compound of carbon and the new gas. He also showed that the part of common air which is absorbed by metals and expelled from their calces is that portion of atmospheric acid which he described as "vital air" or "air éminemment respirable."

The whole story is an interesting one, for to us to whom the answer to the riddle is so familiar, the curious failure to see the problem in its true light—a problem which seemed almost to thrust its solution upon the observer—is not the least remarkable part of the story.

To begin with, we find Hales recognising the

increase in the weight of lead by the absorption of air in the formation of the calx and its expulsion on heating. Similar observations were made by Priestley, the loss of air from mercuric oxide was noticed by Bayen, yet neither Hales nor Priestley were able to piece together these two phenomena, and even Lavoisier, to whom the facts were perfectly familiar, and who was keen on the scent of the air fixed during calcination, does not seem to have thought of repeating Hales' or Bayens' experiment until he fell in by chance with Priestley, who suggested the necessary key and thus furnished the true answer to the riddle.

As in all great discoveries it is difficult to assign rigorously the exact proportion of merit to the individuals participating in it, for the process is generally a gradual one, as in the building of an arch in which each stone contributes its share to the structure until the key-stone is finally laid which binds the whole together.

The steps in the discovery are the observation of Hales, who noticed the evolution of gas on heating the calx, that of Priestley, who observed the effect of the gas on a burning candle and suspected it to be nitrous oxide, and Lavoisier, who first explained its true nature and its rôle in calcination and combustion.

A NEW FORM OF ISOMERISM.

By JOHN CANNELL CAIN, D.Sc., PH.D.

THE value and need of chemical research has been insisted upon by countless authorities, both scientific and technical, and much has been written in favour of the endowment of research. Their ideal would perhaps be to have a large sum of money at the disposal of university and other authorities, so that a student at the end of his course would be able to go to these authorities and say, "I should like to spend some years at research work and desire to be financially free during this period." If he had taken a good degree or otherwise satisfied his professors, doubtless, in the circumstances imagined, he would receive a satisfactory reply.

There are, however, many young students who, even under the present conditions, feel that they would like "to do research" but—one has met them—are anxious to know how to begin. Of course some bright beings are born researchers and can go straight ahead, some become researchers after much travail, and some have research thrust upon them (by their professors!). The average man, it is pleasant to think, has received the impetus to advance his science through intercourse with his teachers, but often finds a difficulty in making a start or developing ideas. He may diligently read the original papers in the various journals with the hope of some idea occurring to him, and this course is often of great assistance, although it occasionally ends in the decision to prepare organic bromine compounds when the paper read has dealt with organic chlorine compounds.

Another, and perhaps a better way, is to make a

careful study of even a single page of that apparently not very exciting, in the truest sense, novel, the well-known Richter's "Lexikon of Organic Compounds," or Hoffmann's corresponding work on inorganic compounds. In the former, at any rate, there will occur under very many formulæ the cut-and-dried compounds with the positions of their various constituents duly assigned. Then, however, comes the name of one of these, repeated, with the position numbers left out and an interrogation mark in their place, or perhaps the name is preceded by the suggestion that this is possibly an isomeride. It is a fascinating occupation to search out these undefined compounds and to try and make out what they may be. In the case of one described years ago it is occasionally possible to fix its constitution in the light of more recent work (the later description, for example, of all its possible isomerides), but often the inquirer is left no wiser than before. Obviously he would like to find a solution to the problem, and the next step is to the laboratory.

Many of the instances mentioned above are to be found among the derivatives of diphenyl, and the investigation of one of them has led to interesting results.

Among the dinitrodihydroxydiphenyls occurs 3 : 3'-dinitro-4 : 4'-dihydroxydiphenyl



and a ? dinitro-?-dihydroxydiphenyl. The first of

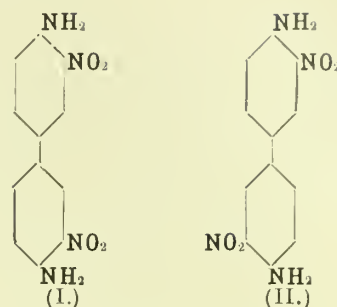
these is obtained by the action of nitric acid on 4:4'-dihydroxydiphenyl (*p*-diphenol), and the second by oxidising orthonitrophenol with permanganate. The latter reaction should apparently give rise to the first compound, but the melting point of the product is given as 184°, whilst that of the above compound is 286°. Another possibility is that the oxidation of orthonitrophenol might yield 3:3'-dinitro-2:2'-dihydroxydiphenyl, which is also known and melts at 189°. The properties of this compound, however, do not agree with those of the product of oxidation of orthonitrophenol as given by their discoverers, and a direct comparison of the two has so far not been possible, owing to the difficulties, not yet surmounted, of oxidising orthonitrophenol satisfactorily and obtaining the compound said to melt at 184°.

However, a third method of preparing 3:3'-dinitro-4:4'-dihydroxydiphenyl is theoretically possible by submitting 3:3'-dinitro-4:4'-diaminodiphenyl (orthodinitrobenzidine) to the action of nitrous acid and boiling the diazo-compound with water. (It may be said at once, in view of what follows, that neither of the two compounds was obtained in this reaction, and this little problem still awaits solution.) Accordingly it was necessary to prepare this orthodinitrobenzidine, which is described in the "Lexikon" as melting at 218–221°. References are also given to three papers dealing with this compound, of which only two concern us. The earlier one, by Strakosch, describes a dinitrobenzidine, prepared by nitrating diacetylbenzidine, as melting at above 300° (the third paper, mentioned above, was concerned with the proof that this was a 3:3'-dinitro-compound). The later paper, by Bandrowski, describes a dinitrobenzidine, prepared by nitrating diphthalylbenzidine, as melting at 218–221°, and Bandrowski concluded that this was probably identical with Strakosch's compound, but was careful to say that the identity could only be established by a direct comparison.

Because, up to quite recently, theory did not allow for the occurrence of two different orthodinitrobenzidines, the later work, at any rate as regards the melting point, was assumed to be correct and the earlier incorrect, and consequently the "Lexikon" records only one. This is an extremely good example of the danger of allowing theory to override facts.

However, as both these acyl derivatives of benzidine, the diacetyl and the diphthalyl, should (according to theory) yield the same compound, both the above experiments were repeated in order to throw some light on the matter. The result was to show that in reality two different orthodinitrobenzidines do exist, that prepared by Strakosch's method melting at 275° (instead of "above 300°"), and that from Bandrowski's process melting at 233° (instead of 218–221°).

The next question to be solved was the configuration of these compounds. Could they be represented by the formulæ I. and II.?



In the ordinary course of things one would expect that the bottom half of I. would rotate easily to give II., or *vice versa*, but still the fact remains there are the two separate compounds in which the relative positions of the nitro-groups with respect to the amino-groups have been conclusively proved.

More than one suggestion has been made to explain the existence of these two isomerides, but that based on a different conception of the position of the two phenyl groups in space from that given above—the conception put forward by Kaufler in 1907—appeared to be the most likely one. Kaufler suggested that the two phenyl groups in diphenyl were arranged in space alongside each other thus—



but no decisive proof was adduced in favour of this idea.

If the older formula for diphenyl is cut out in paper and the two benzene rings folded towards each other, the free ends of the rings are brought fairly close to one another. Moreover, if these free ends are attached to amino-groups (as in benzidine) the latter also come close to each other. It seemed worth while to try, if possible, to ascertain *how* close these could be. Now it is easy to determine if a diamine has its two amino-groups in the ortho-, meta-, or para-position with respect to each other, and so, first of all, the reagent (an ortho-diketone) for ortho-diamines was applied to benzidine, with the interesting result that condensation was found to take place with glyoxal and benzil (ortho-diketones) in the same manner as these substances react with ortho-diamines.

It appears certain, therefore, that the amino-groups in benzidine are fairly close together, possibly slightly more apart than in, for example, orthophenylenediamine, but still sufficiently close to point to Kaufler's theory being the correct one.

This step having been disposed of, it remained only to consider the constitution of the two dinitrobenzidines in the light of Kaufler's formula, and it was seen immediately that their existence was easily possible. If the two formulæ I. and II. are arranged afresh, the nitro-groups in I. will come very close to each other, and those in II. will be away from each other. It thus appears probable that the two nitro-groups, possibly through some form of steric

hindrance, would prevent the rotation of one of the benzene rings, and thus the existence of the two isomerides may be explained.

Many other compounds containing the nitro-groups in the above position, but with different groups or atoms in place of the amino-groups, have

been prepared, and in every case corresponding isomerides resulted. Moreover, similar isomeric dinitrotolidines have been prepared, and it is intended to make further investigation in the wide field thus displayed through a casual dip into Richter's "Lexikon."

THE TOXICITY OF OIL PAINT VAPOURS.

By C. A. KLEIN.

THE hygienic importance of the vapours given off by drying paints had not until quite recently been realised, but now that some of the effects of these vapours have been determined, a great deal of attention is being paid to the subject. In this country it was not until 1912 that the subject received any attention of note, but since that date Goadby,¹ Armstrong and Klein² have in different ways approached the question, and as a result have established the fact that serious physiological disturbances are produced by the inhalation of paint vapours, the toxic effects of which they ascribe to the volatile thinning constituent of the paint. These volatile constituents produce definite toxic effects, and have been described in this journal by the present writer.³ Recently Gardner⁴ claims to have traversed the work of former workers, and in a paper, entitled "The Composition of Paint Vapours," describes certain experimental work which leads him to the following conclusions:—

(1) When linseed oil or similar drying oils are spread in thin layers, the absorption of oxygen which takes place is accompanied by the evolution of considerable amounts of carbon dioxide and organic substances. Carbon monoxide is also evolved in small amount.

(2) Oil paints containing lead or zinc pigments do not emit volatile compounds of a metallic nature.

(3) Drying paints evolve water-soluble acid substances, such as formic acid, as well as acid substances which are apparently of a fatty nature. Carbon dioxide and carbon monoxide are also present in the vapours from the drying paint. The type of pigment used in the paint may directly affect the amount and character of the volatile substances produced. Basic pigments apparently stimulate the evolution of such products.

(4) Aldehydic substances are present in the vapours from drying oil paints. These substances probably have a marked bactericidal effect upon pathogenic bacteria, thus accounting for the sanitary value ascribed to oil-pigment paints.

In a subsequent communication,⁵ entitled "The

Toxic and Antiseptic Properties of Paints," by the same author, read before the thirtieth annual convention of the International Association of Master House Painters and Decorators of the United States and Canada, held at Indianapolis, on February 12th, 1914, the subject is further discussed, and the hygienic bearing of the work is enlarged upon in the following words:—

Composition and Toxicity of Oil Paint Vapours.

"In a paper entitled 'The Composition of Paint Vapours' the writer has recently published the results of an extended research into the character of the volatile vapours given off by various paint materials. This work was originally designed to determine whether the fumes evolved from drying white lead paint contained volatile lead compounds which, if inhaled, might cause lead poisoning. The tests, however, proved that paint vapours do not contain metallic ingredients, and are, therefore, not to be held accountable for cases of lead poisoning from which painters may suffer. The most important outcome of the tests was the discovery of carbon monoxide in the vapours of drying paints. Since this substance is an extremely poisonous gas, it is quite fair to assume that its inhalation in unventilated rooms which are being painted constitutes the real cause of that peculiar type of anæmia from which painters sometimes suffer."

In further discussion as to the influence of vapours of turpentine or similar volatile thinners on blood corpuscles (which, according to Armstrong and Klein, is such that the observed changes can be ascribed to these vapours) Gardner states that he "is convinced that the change in the blood corpuscles of a person who had breathed the fumes of drying paint in an unventilated room is more likely due to the effect of the carbon monoxide evolved by the paint. The use of turpentine doubtless stimulates the oil present to give off larger quantities of such gas, but the effect of turpentine should be cited as a contributory effect in this respect. Carbon monoxide, if present in appreciable percentage, is really the most poisonous constituent of the vapour from drying oil paint."

This statement is one of great importance, as, if it could be shown that vapours from drying paint contain carbon monoxide in appreciable quantity, then doubtless the well-known effects of this gas would present themselves, though the effect of

¹ Goadby, "Lead Poisoning and Lead Absorption," Arnold, London, 1912, 108.

² Armstrong and Klein, *Journal Soc. Chem. Ind.*, 1913, Vol. 32, 7, 320.

³ Klein, *Chemical World*, 1914, Vol. 3, 5.

⁴ Gardner, *Journ. Ind. and Eng. Chem.*, 1914, Vol. 6, 2, 91.

⁵ Bulletin 41, Educational Bureau—Paint Manufacturers' Association of the U.S., reprinted in *Oil and Colour Trades' Journal*, 1914, Vol. 45, 1000.

turpentine in producing blood changes cannot be regarded as secondary, inasmuch as pronounced changes are recorded by various workers whose experiments have been confined solely to turpentine and similar thinners in the absence of drying oil or pigments.

The experimental method adopted by Gardner consisted in aspirating air freed from carbon dioxide and carbon monoxide through bottles painted with linseed oil, or paints containing this vehicle, the paint vapours thence being led through fuming sulphuric acid, distilled water, barium hydrate solution, iodine pentoxide (heated to 150° C.), 1% potassium iodide solution, and, finally, barium hydroxide solution. The iodine liberated from the iodine pentoxide was collected in the 1% potassium iodide solution, and subsequently determined by titration with thiosulphate. As the result of seven experiments, the following figures were obtained:—

1. Linseed oil.	Traces of CO.	5 hours' aspiration.
2. White lead and linseed oil.	0.006% ..	"
3. Zinc oxide and linseed oil.	0.0039% ..	"
4. Lithopone and linseed oil.	Mere traces.	"
5. White lead and linseed oil.	Positive evidence of formation of potassium formate from CO + solid KOH. Quantity undetermined.	"
6. Lithopone, linseed oil and turpentine.	0.0003%	3 hours' aspiration.

In experiments 2, 3, 4 and 5 a "paint" containing 60 per cent. pigment and 40 per cent. linseed oil was used, whilst in experiment 6 a portion of lithopone paint reduced with 15 per cent. of turpentine was used.

Although not clearly stated, the carbon monoxide is apparently calculated as a percentage of the paint used.

Experiment No. 6 was undertaken to determine the influence of turpentine on the supposed formation of carbon monoxide in the drying of paint mixtures. For this purpose a lithopone, linseed oil and turpentine paint was used, and after three hours' aspiration 0.0003% of CO was recorded, as compared with "mere traces" after a five-hour aspiration the bottles painted with lithopone linseed oil mixture. From this experiment it is concluded that "the result may be due to oxidation of the turpentine" and that "turpentine apparently accelerates the reactions of volatile products from drying oils. The oxidative properties of turpentine are probably responsible for this result."

The general conclusions of Gardner are in agreement with those arrived at by previous workers, and it is intended in this communication to discuss only that portion of the work relative

to the detection of carbon monoxide. In the first place it is recorded that the painted surfaces of the bottles remained quite wet after five hours' aspiration, and, further, there is no statement as to the quantity of air passing through the bottles. Information on the foregoing points is necessary before any data of hygienic value can be deduced from such experiments.

In view of the varying rates of drying possessed by paints made up with different pigments, the experiments should have been carried out to some point where the extent of oxidation of the oil in each case was similar, or preferably to dryness, so that practical conclusions could be drawn. The more rapid drying of white lead paints as compared with those of zinc oxide or lithopone is well known, and the more rapid evolution of volatile products from the oil of such paints appears to have been ignored in these experiments. The effect of turpentine in increasing the drying rate of paints is well known, and this effect is doubtless responsible for the observation that lithopone paint containing turpentine is reported as yielding a measurable quantity of carbon monoxide in three hours as compared with "mere traces" obtained by aspiration for five hours through bottles painted with lithopone and linseed oil alone.

On reading through the accounts of Gardner's experiments, the present writer came to the conclusion that the experimental method was open to serious criticism, in view of the fact that, although the presence of formic acid in "paint vapours" is recorded and demonstrated (an observation made by many previous workers), it was not recognised that formic acid when passed through fuming sulphuric acid gives rise to carbon monoxide. Six experiments are described in which carbon monoxide was detected, and in every case the paint vapours containing formic acid were passed direct through fuming sulphuric acid without any provision being made for the removal of the formic acid prior to this treatment. It is stated that "the absorption of these organic vapours by the sulphuric acid prevented such vapours from interfering with the subsequent train of liquids in which the carbon dioxide and carbon monoxide were to be determined."

The importance of the subject led the present writer to investigate the problem in order to ascertain whether carbon monoxide is in reality produced as described. Experiments, which are still in progress, have shown conclusively that the carbon monoxide observations of Gardner are wholly invalid, and the formation of this gas in the experiments described by Gardner is to be ascribed to interaction between the formic acid of these vapours and the fuming sulphuric acid, through which they were passed on leaving the drying chamber.

The figures quoted as to the quantities of carbon monoxide produced from different paints are meaningless except perhaps in so far as rate of drying might be indicated. In practice, rates of drying are equalised by means of "driers" so that final conditions are similar.

It must also be noted that the mixtures used by Gardner in no way resembled paint, and the practical value of the results is in any case reduced.

A number of points of experimental importance have been brought to light in this investigation, but it is sufficient here to place on record the fact that the carbon monoxide observations of Gardner are unsound, and cannot be accepted. It is curious that in certain quarters results of this kind readily gain credence without any attempt at experimental verification or due consideration, and if this article

serves only as an indication of the necessity of substituting detailed investigation for sensationalism in the study of the problem of "Paint Vapours," it will have achieved its end.

No evidence has yet been brought forward indicating that there is any ground for importing a new source of danger into the problem of painters' hygiene, but there is distinct evidence that the hygienists now realise the complexity of their task, and are investigating in more detail sources of danger hitherto disregarded.

CHEMICAL INDUSTRIES.

A Monthly Review of the Progress of Technical Chemistry.

THE ELECTROLYTIC PREPARATION OF "PER-SALTS."

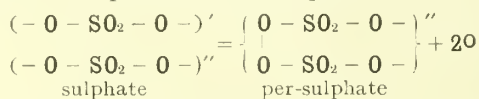
By E. K. RIDEAL, Ph.D., B.A.

THE demand for oxidising salts containing relatively large amounts of available oxygen is steadily increasing, and their preparation on a large scale is now no longer a matter of private interest, but has become an industry of no mean order.

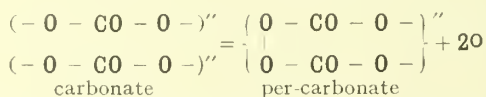
Among the more important substances used for technical purposes may be mentioned the perchlorates for the explosive and firework industries; these salts also find a market in the preparation of electrolytic meters. The dichromates are used extensively in the dyeing industries and in organic chemistry generally. The perborates find an application in laundries, while numerous uses can be found for hydrogen and other peroxides, as well as for persulphates.

In the cases of the true "per" salts the electro-chemical production may be regarded as a special case of anodic polymerisation. This is generally effected by a relatively high current density permitting of the rapid formation of an unstable compound which in turn can polymerise to a more stable form. For this purpose the electrode at which the polymerised product is to be formed must be very small in order that the current density may be great. Cooling is usually necessary.

The two discharged ions combine to form the more complex one as represented in the equations:



and



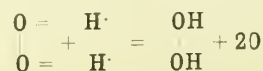
It is evident that for efficient yields the discharge of other ions must be brought as low as possible. The usual ions present which cause lower yields are hydroxyl ions from the water, acid solutions render their discharge more difficult and these are frequently employed. In the preparation of persulphates platinum anodes and nickel lead or platinum cathodes are used while the anolyte is a well-cooled saturated solution of ammonium or potassium sul-

phate. To prevent subsequent cathodic reduction of the persulphate the cathode is occasionally placed behind a diaphragm; but when no diaphragm is used, addition agents such as potassium chromate, potassium ferrocyanide, potassium cyanide, other complex cyanides, thiocyanates and cyanates are added to increase the yield; in these cases nickel cathodes have been successfully used, while the use of aluminium and tin for this purpose has been suggested. In making sodium persulphate it has been found advisable to add a little potassium salt in order to obtain a coherent and a non-flocculent precipitate of the per salt. In dilute solutions the efficiency is increased by the addition of potassium chlorate, hydrochloric acid or other chlorides as well as fluorides, but these are not necessary in more concentrated electrolytes. The current density employed varies from 20 to 50 amps./dm.², while the voltage employed is about seven in the case of the non-diaphragm cells, rising to twenty in these latter ones.

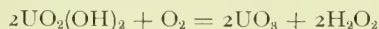
For the preparation of perborates lower current densities 2—4 amps./dm.² are used, the solution being a mixture of sodium carbonate and borax, while for percarbonates a saturated solution of potassium carbonate cooled to 15° C. can be employed.

Hydrogen peroxide is usually formed by the distillation *in vacuo* of persulphuric acid. Various substances are added as stabilisers for the hydrogen peroxide solution, since it is liable to decomposition, especially in presence of certain catalysts. Among the stabilisers that have been used may be mentioned acetanilide, tannic acid, gum, starch, barbituric acid, alcohol, stearic acid, soap, barium acetate, phosphoric acid, and sodium chloride.

More recently a continuous process of manufacture has been investigated with promising results. The principle employed is that of reduction of oxygen by electrolytic hydrogen. Dilute sulphuric acid saturated with oxygen under 100 atmospheres pressure is electrolysed at 5 amps./dm.² with two volts P.D., and 90% yield of hydrogen peroxide is said to be obtained when some efficient device for circulating the oxygen-charged electrolyte to the cathode compartment is employed. This reaction supports the dihydroxyl constitution for hydrogen peroxide. Its formation by this process may be graphically represented as



The effect of different cathodic materials on the yield obtained by this process has as yet not been investigated; it is probable that metals possessing a high over potential value for hydrogen, such as mercury and tin, will prove most efficient. The presence of some salt which can exist as an oxide and hydroxide and which is deposited on the cathode by the electric current, *e.g.*, uranium oxide, might prove effective, a reaction such as



being possible.

Perchlorates are usually prepared by the electrolysis of sodium or, better, potassium chlorate solutions saturated at 10° C. between platinum anodes and iron cathodes. The current density employed is 4—12 amps./dm.² at about seven volts. From 70—90% of the oxygen evolved at the

anode is liberated in the form of ozone. The presence of alkalis hinders the formation of perchlorates (which are not produced until nearly all the chloride has been converted into chlorate), consequently the electrolyte must be kept slightly acid.

The current efficiency at the commencement is about 96%, but subsequently falls to 85%.

In many factories the "per-salt" is not directly isolated; for instance in certain laundries where per-borates are used for bleaching purposes, the electrolyte from the per-borate plant is allowed to run into the vat where the bleaching effect is desired; subsequently the spent liquor is returned to the electrolyser and is there re-oxidised. This cycle of operations permits of many variations and is one in which the economic advantage of electrolytic preparations over purely chemical processes is very marked.

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

CHAPTER VII. (*continued*).

OXIDATION.

THE most important processes involving catalytic oxidation are inorganic in character, and most of these have already been dealt with in Chapters II., III., and IV. Scattered throughout the domain of organic chemistry, however, are a multitude of catalytic reactions which can be classified under the general heading of oxidation processes. It is intended to devote most of the remainder of this chapter to a brief survey of these processes. Oxidation by electrolysis and fermentation will be dealt with in a later chapter.

(a) *Colour Industry*.—One of the most valuable dyes in the whole range of synthetic colours is aniline black. This dye is prepared by the oxidation of an acid aniline salt with manganese dioxide, lead peroxide, chromates, ferric salts, permanganates and chlorates, in the presence of certain metallic salts which act as carriers and are essential to the production of the black. The most remarkable of these carriers is vanadium pentoxide. According to Witz (1876), the addition of one part of the oxide to the mixture of aniline salt and chlorate is sufficient to convert 270,000 parts of the aniline salt into aniline black. After vanadium, in order of efficiency come cerium, copper, uranium and iron, employed in the form of various salts. Recently it has been claimed that osmium tetroxide possesses superior activity. All of these metals, it will be noticed, are capable of two degrees of oxidation.

In 1907, Green patented a process for the production of aniline black in which the oxidation is effected by the atmospheric oxygen, instead of by the use of an oxidising agent, thereby avoiding "tentering" or weakening of the fibre on which the dye is developed. The process depends upon the discovery that the addition of a small quantity of a paradiamine or a para-amidophenol to a mixture

containing aniline and an oxygen carrier, such as a copper salt, greatly accelerates the atmospheric oxidation. The reaction is believed to be effected by the joint catalytic agency of the metallic carrier, associated with an organic body of the type above mentioned.

Fuchsine or magenta is another important dye whose preparation involves the use of a catalytic agent. Formerly arsenic acid was used for the oxidation of "aniline oil for red"—a mixture of about one part aniline with two parts *o* and *p* toluidines—but it has now been replaced by nitrobenzene or formaldehyde. In the case of nitrobenzene, metallic iron or ferrous chloride is added to the mixture and serves as an oxygen carrier. Ammonium vanadate may also be used.

In the production of methyl violet from dimethylaniline using chlorate as the oxidising medium, cupric chloride is always added on account of its catalytic properties. When chlorate is dispensed with and atmospheric air employed, the phenol which is then added is supposed by some to act as a catalyst too.

The synthesis of indigo by Heumann's process (1890), which is worked by the Badische Anilin u. Soda Fabrik, incorporates a splendid example of the catalytic acceleration of a reaction. The starting point of the synthesis is the oxidation of naphthalene into phthalic acid, and it was the accidental discovery of the catalytic influence of mercury when strong sulphuric acid is employed—the result in fact of the breakage of a thermometer in one of the experimental tanks—which has rendered practicable the commercialisation of this elaborate synthesis.

As it happens, mercuric sulphate is much the most powerful catalyst of the process of oxidation by means of sulphuric acid. The sulphates of potassium, magnesium, etc., are inefficacious, whilst those of iron and nickel act but feebly. Only copper

sulphate can replace mercuric sulphate, and then without advantage. A mixture of the two sulphates of copper and mercury, nevertheless, displays an activity greater than the sum of both taken separately.

Incidentally it might be mentioned that mercury possesses a parallel catalytic effect in the Kjeldahl process for the estimation of nitrogen in an organic body.

Though not oxidation processes, there are several catalytic reactions in connection with the colour industry which are conveniently dealt with at this stage. These reactions are concerned chiefly with the application of hydrosulphite-formaldehyde compounds to the discharging of colours.

In 1905, Baumann and Tnesmar observed that the power of these bodies to destroy the colour of a whole series of dyes, such as naphthylamine claret, chloranisidine orange, benzidine brown, etc., was greatly facilitated by the addition of an alkaline solution of an iron salt. Salts of nickel and tin were also found to have a beneficial effect, whereas almost all other metallic salts had no influence whatever.

A year later it was discovered by Wilhelm that minute quantities of certain dyestuffs themselves increased the discharging effect—an observation quite as surprising as that of the effect of vanadium salts upon the production of aniline black. Thus, the Badische firm have shown that a very small quantity of induline scarlet present in the discharge paste greatly facilitates the destruction of the colour of many dyes. Setopaline and patent brown act in a similar fashion.

The above means for increasing the reducing power of hydrosulphite-formaldehyde compounds upon azo colours has also been found applicable to the discharge of indigo, thioindigo and similar dyestuffs, a reaction which had previously presented great difficulty. One part of anthraquinone or induline scarlet to 1,000 of the discharge paste is quite sufficient to give the required effect.

(b) *Preparation of Organic Acids.*—The laboratory method for the preparation of oxalic acid consists of the oxidation of sugar or starch by means of hot nitric acid. This method was formerly employed upon a large scale, but has since been superseded by other processes. It is possible, however, that the method may be revived, as a result of the discovery by Naumann (1905) that the addition of a trace of vanadic oxide—1 gm. per 1,000 gms. of sugar—greatly accelerates the reaction. Using this catalyst, the reaction proceeds at the ordinary temperature, and higher yields are obtained owing to the suppression of intermediate products such as saccharic, mucic and tartaric acids.

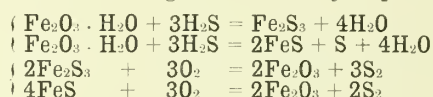
In a recent German patent, the presence of molybdenum compounds is stated to accelerate all reactions, including the above, in which nitric acid is used as an oxidising agent.

Acetic acid, again, is another acid which can be prepared catalytically. Alcohol, placed in a vessel over which spongy platinum is arranged with free

access to the air, undergoes slow oxidation to acetic acid. The product is a very pure one, but the process is not practised on an industrial scale on account of the high initial cost of the platinum. The catalyst suffers practically no deterioration.

(c) *Purification of Illuminating Gas, etc.*—The removal of the injurious sulphuretted hydrogen from lighting gas is invariably effected by passing the gas through moistened absorbent materials, chief among which are lime, ferric oxide, and manganese dioxide.

The latter two materials may be regarded as functioning in a catalytic manner, for when they cease to absorb, exposure to the air reconverts them into the original material. In the case of ferric oxide, the absorption manifests itself by a change in colour from black through reddish-brown to a dirty green, the change being due to the gradual production of sulphide. Revivification results in the deposition of the sulphur and reproduction of the oxide. The changes are usually represented:—



Artificial iron oxide is generally found to be more vigorous than the natural bog iron ore. Manganese dioxide, in the form of Weldon mud, is now replacing ferric oxide, for it, too, can be readily revived and possesses besides an affinity for sulphuretted hydrogen which is from four to five times as great as that of bog ore. Lime, when spent, is thrown away and does not therefore act as a catalyst.

The catalytic function of ferric oxide and manganese dioxide is emphasised by a modern development in gas purification, in which the spent oxide is revived *in situ*. This is effected by admitting a certain amount of air with the gas and has the advantage of enabling the purifiers to be worked much longer without recharging.

Ferric oxide or Weldon mud also acts as a carrier for the active oxygen of saltpetre or other oxidiser used to purify caustic soda of sulphides and thio-sulphates.

(d) *Paint Industry.*—The drying of the oil which forms the most important constituent of paints, varnishes, etc., is such a slow process that it is usual to add to the oil some material, known as a "siccative," which accelerates the "drying" or hardening. These bodies furnish a good example of a particular type of catalysis mentioned in Chapter I.

First, it should be noticed that the drying process *per se* is a catalytic one. Broadly speaking, hardening is the result of the absorption of oxygen from the air whereby intermediate products—usually considered to be peroxides—are formed which catalyse the formation of still more of the products, the latter being ultimately changed into some indefinite compound. In the case of linseed oil, the final product is "linoxyn." The main reaction is, therefore, one of auto-catalysis.

That this is the case will be seen from Fig. 12, which represents the alteration in weight of a drying

oil upon exposure to the air in thin films. The very shape of the curve, S-shaped, is typical of an auto-catalytic process.

OA represents the "induction period" during which the weight of the oil remains fairly constant, whilst small quantities of peroxides, the natural driers, are being produced. At A, the accumulation

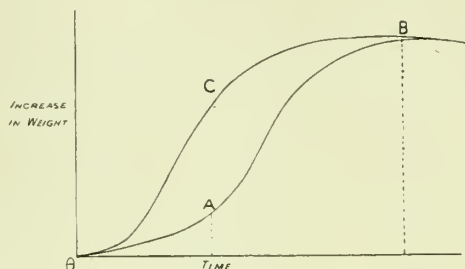


FIG. 12.

of peroxide is sufficient to effect a notable increase in the absorption of oxygen, and from that point the reaction proceeds with gradually increasing rapidity until, at B, a maximum is reached. Beyond that point slackening occurs, consequent upon the decreasing concentration of the reacting substances.

When a sicative is employed the induction period is reduced, but the S-shape of the curve is

still maintained (see curve OCB). The sicative, therefore, functions as a pseudo-catalyst, since it accelerates the production of the auto-catalyst.

As might be anticipated, the most powerful driers are themselves comparatively unstable peroxides. Manganese dioxide and red lead are those most commonly employed, though many other metallic oxides possess some degree of activity. Recently, Fokin has shown that cobalt compounds possess greater activity than those of either manganese or lead. Such organic substances, too, as turpentine, which absorb oxygen with the probable formation of peroxides, possess some capacity for acting as driers. Rosin is another body of this class, and combined with manganese or lead produces a good drier. The same applies to manganese linoleate, lead oleate and the like, which, being soluble in both turpentine and linseed oil, are known as "liquid driers." Whatever drier be employed, the quantity necessary is very small. In the case of manganese dioxide, for instance, 5 lbs. per ton of oil is all that is required.

In the manufacture of linoleum, numerous attempts have been made to accelerate the slow hardening process, but in all cases the resulting product has been inferior to that obtained from the unassisted oxidation of the linseed oil.

(To be continued.)

SURFACE TENSION AND SURFACE ENERGY AND THEIR INFLUENCE ON CHEMICAL PHENOMENA.

By R. S. WILLOWS, M.A., D.Sc., and E. HATSCHEK.

CHAPTER VIII.

We have seen in the preceding chapters that a considerable amount of both experimental and theoretical evidence points to the existence of a transition layer at the boundary of two phases—in other words, of a layer in which the concentration of the phases is different from that in the bulk. It will, therefore, be advisable to consider quite generally what factors affect the concentration—for instance, the distribution of a solute in a solvent.

Let us assume a solution of a non-electrolyte in water, separated from the pure solvent—water—by a semipermeable membrane forming a piston (Fig. 8). Water enters the solution through the membrane and raises the piston, *i.e.*, the solution can do work or possesses potential energy owing to its osmotic pressure. If the membrane is removed, the osmotic pressure causes diffusion until (if no other forces are active) the solute is uniformly distributed through the solvent. Osmotic pressure is, therefore, a factor tending to bring about uniform concentration.

If the particles of the solute are electrically charged, work is required to bring them more closely together. This is the reason why a suspension, the particles of which are electrically charged, does

not settle if the particles are sufficiently small, *i.e.*, if their weight is small compared with the forces arising from the charges on them. An electric charge on the particles of the solute is, therefore, a further factor tending to keep the particles uniformly distributed in the solvent.

A third factor governing the final distribution of the solute is the surface energy. This becomes obvious if we consider the total energy of the system. If the dissolved substance diminishes the surface tension of the solution, an excess of concentration in the surface layer diminishes the surface energy and therefore the total energy of the system.

If, on the other hand, the solute increases the surface tension, the surface energy will be reduced if the concentration in the surface layer is lower than that of the bulk of the solution. This difference in concentration between the surface layer and the bulk of the solution is called adsorption and is, from our

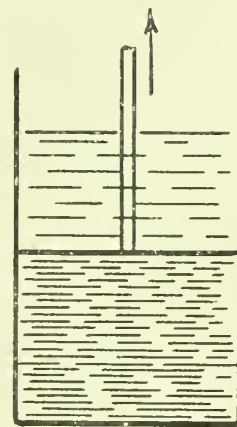


FIG. 8.

point of view, a purely physical, as distinguished from a chemical effect. It is called positive when the concentration in the surface layer is greater, and negative when it is smaller than that in the bulk of the liquid. Adsorption is evidently opposed by the factors tending to establish uniform concentration, *i.e.*, osmotic pressure and electric charge, and the final distribution of the solute is the resultant of the three effects.

The mathematical theory of adsorption was first developed by Willard Gibbs and later, independently, by Sir J. J. Thomson. We must confine ourselves to giving the result of their investigations. Let c be the concentration of the solute in the bulk of the solution and u the excess concentration, in grammes per square centimetre, in the surface layer; u is, of course, taken as positive if the concentration in the surface is greater, and as negative if it is smaller than c . We assume for the present that the solute is undissociated and that the particles or molecules are not electrically charged.

It can then be shown that

$$c \frac{d\sigma}{dc} = -u \frac{dp}{dc}$$

where p is the osmotic pressure. For dilute solutions the osmotic pressure is given by the formula:—

$$p = R\theta c$$

in which θ is the absolute temperature and R a constant, and dp is therefore

$$dp = R\theta dc$$

If we introduce these values in the first equation, we obtain

$$c \frac{d\sigma}{dc} = -uR\theta \text{ or } u = -\frac{c}{R\theta} \cdot \frac{d\sigma}{dc}$$

$\frac{d\sigma}{dc}$ is the differential coefficient of the function connecting surface tension and concentration and is therefore positive if σ and c increase together, and negative if σ decreases with increasing c —in other words, positive if the solute increases the surface tension and negative if it diminishes the latter. The whole product on the right hand of the equation will, therefore, be negative in the first case and positive in the second, *i.e.*, u , the excess in the surface layer, will be negative when the solute increases the surface tension and positive when it reduces it, so that there will be a lower concentration in the surface in the former case, and a higher concentration in the latter. This reasoning is conclusive, as R , c and θ are all necessarily positive and the sign, therefore, depends only on that of $\frac{d\sigma}{dc}$.

No assumption is made about the nature of the boundary, and the formula should apply to all combinations, such as solid-gas, solid-liquid, liquid-liquid and liquid-gas. If the solute is dissociated, the osmotic pressure is

$$p = iR\theta c$$

and therefore (assuming that the constant i does not change appreciably with c)

$$u = -\frac{c}{iR\theta} \cdot \frac{d\sigma}{dc}$$

As dissociation is, however, accompanied by the formation of electric charges, a further complication arises, to which we will refer later.

An important qualitative conclusion, which agrees with experience, can immediately be drawn from the theoretical considerations we have developed. A small quantity of dissolved substance may reduce the surface tension very considerably, but can only increase it slightly. Thus, sodium chloride increases the surface tension of water to a small extent; the concentration in the surface layer is accordingly smaller than in the bulk and the effect of the solute is thus counteracted. On the other hand, many organic salts, *e.g.*, the oleates, reduce the surface tension and therefore accumulate in the surface layer, so that, in extreme cases, the whole of the solute may be collected there and produce a considerable effect, although the absolute quantity may be exceedingly slight.

This state of things has actually been obtained with salicylic acid in a concentration of 0.22 millimole per litre.

In most cases it is necessary to employ very large surfaces to obtain measurable effects, and this has been done in a variety of ways. Miss Benson examined an aqueous solution of amyl alcohol by producing a copious froth on it and comparing the alcohol concentration in the froth, which has a very large surface, with that in the bulk of the solution. Since amyl alcohol reduces the surface tension, the excess in the surface should be positive, *i.e.*, the alcohol concentration should be greater than in the rest of the liquid. The following figures confirm this conclusion:—

Original solution	..	$c = 0.375$ molar
Froth	..	$c_1 = 0.394$ „
Excess in surface	..	$u = 0.019$ mole

so that the concentration in the froth is about 5% higher than in the original solution.

Another method of obtaining a large surface and at the same time of demonstrating adsorption at the boundary liquid-liquid consists in allowing drops of, say, mercury to fall through a solution and determining the concentration after a certain number of such drops have passed through. Many solutes can be almost completely removed from solution in this way, *e.g.*, picric acid.

Experiments like Miss Benson's afford qualitative confirmation of the adsorption formula, but do not test it quantitatively. For this purpose it is obviously necessary to determine not only the various constants of the formula, but also, and chiefly, $\frac{d\sigma}{dc}$ —in other words, to determine how surface tension varies with concentration. If we do so for a number of concentrations and plot a curve, we can deduce $\frac{d\sigma}{dc}$ from it, and we accomplish something

further—we obtain a very delicate method of measuring the very low concentrations which have to be dealt with. To ascertain, for instance, the concentration in a solution after adsorption has taken place, we have only to measure the surface tension and can then at once find the corresponding concentration from the σ - c curve previously determined.

A quantitative test of the Gibbs-Thomson formula will accordingly involve the following measurements: we first determine the surface tension of a solution for a number of different concentrations, plot the σ - c curve and from it determine $\frac{d\sigma}{dc}$ for a given c . We then bring a solution of this concentration c into contact with an adsorbent, the surface of which we must be in a position to determine. After a time of contact sufficient to establish equilibrium the concentration is again determined, *e.g.*, by measuring the surface tension, and the difference represents the amount adsorbed by the whole surface of the adsorbent. This difference, divided by the surface, is therefore the amount adsorbed by the unit of surface, that is, the term u in the formula.

The procedure just outlined was adopted by Wm. C. McC. Lewis, the solution being one of sodium glycocholate in water and the adsorbing surface the interface paraffin-oil solution. The surface tension at different concentrations was determined by the drop method, to which brief reference must be made. If a drop of liquid forms at the end of a tube, it is supported by the surface tension acting round the circumference and at the moment when the drop is detached, some relation must exist between the weight of the drop and the surface forces. If we call a the external radius of the tube, m the weight of the drop in grammes, g the gravity constant, and σ the surface tension, it can be shown that:—

$$\sigma \pi a = mg \text{ or } \sigma = \frac{mg}{\pi a}$$

Lord Rayleigh has, however, found that this formula does not agree exactly with experimental results and that, for water, the denominator must be multiplied with 1.21, *i.e.*, a factor 3.8 substituted for π . The theory of this discrepancy is complicated and inexact. There is, however, no objection to the method for comparative or relative measurements, but in actual practice it is more convenient to determine the number of drops in a given volume, *e.g.*, from a pipette with two marks, rather than the weight of a drop. If the surface tension decreases, the drops will be smaller, as the smaller tension can only support a smaller drop, and the number of drops will be larger. Other things being equal, the surface tension will be inversely proportional to the number of drops. The method is applicable not only to the determination of surface tensions, but also to that of interfacial tensions of liquids against each other. It must, however, be borne in mind that, when one liquid forms drops in another, the actual weight of the drop is diminished by the weight of the liquid

it displaces; if the ratio of the densities is, *e.g.*, 1:2, the effective weight of a drop of the heavier liquid is halved. It can easily be shown that the interfacial tension is

$$\sigma = \frac{mg}{\pi a} \left(\frac{\rho - \rho^1}{\rho} \right)$$

where ρ and ρ^1 are the densities of the heavier and lighter liquid respectively, and the other symbols have the same meaning as before.

Lewis, as already mentioned, used a solution of sodium glycocholate and determined the adsorption of the salt by a surface of paraffin oil. The σ which enters into the formula is, therefore, the interfacial tension solution—paraffin oil; this was measured for a number of concentrations by the drop method just discussed, and the σ - c curve plotted (Fig. 9). The rest of the procedure will be best illustrated by an actual numerical example. Five hundred cubic centimetres of a solution containing approximately .33% of the salt was shaken

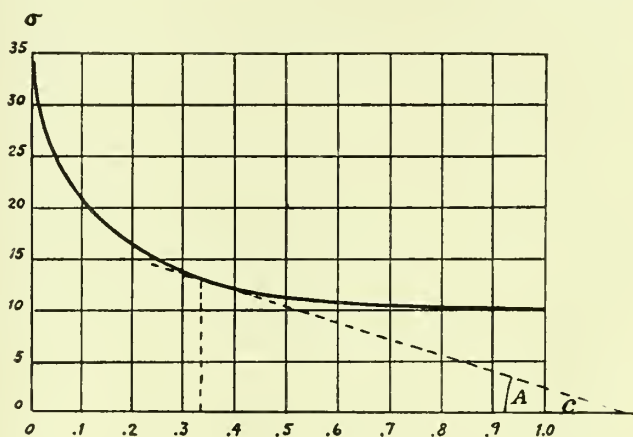


FIG. 9.

with .447 c.c. of oil for 12 hours to form an emulsion. A number of the oil globules thus formed were measured by the microscope, and the average radius found to be 425×10^{-7} cms. From this it is possible to calculate the surface, $4\pi r^2$, and the volume, $\frac{4}{3}\pi r^3$, of a drop. The number of drops is accordingly the total volume of oil used divided by the volume of one drop:—

$$N = \frac{.447}{\frac{4}{3}\pi r^3}$$

The total surface of oil in contact with the solution is the number N , of drops, multiplied by the surface of one drop, and was found to be 31,553 sq. cms.

After allowing the emulsion to stand for a time the drop number was taken, the assumption being made that the oil globules would have no effect. The figures were:—

Before emulsification:

Drop number = 483 $\sigma = 12.8$ $c = .318\%$

After emulsification:

Drop number = 459 $\sigma = 13.4$ $c = .295\%$

The change in concentration, therefore, amounts to .023 %, so that the total amount removed from the solution by adsorption on the surface of the oil drops is .115 gm. Hence the amount adsorbed per square centimetre— u in the formula—is this weight divided by the surface of oil :—

$$u = \frac{.115}{31,553} = 3.6 \times 10^{-6}$$

It is also possible to calculate u from the formula, as the values of R , θ and c are known, and the value of $\frac{d\sigma}{dc}$ can be obtained from the σ - c curve (Fig. 9).

If the tangent to the curve is drawn at the point having $c = .318\%$ as abscissa, the trigonometrical tangent of the angle A is $\frac{d\sigma}{dc}$.

A serious discrepancy was found between the experimental and the calculated values of u , the former being 20—30 times greater than the latter. This is no doubt due in part to the experimental errors involved in the method, inasmuch as the size of the oil globules in the emulsion varies considerably and it is therefore difficult to obtain a reliable value for the radius, and consequently for the total active surface.

The experiment was therefore varied by allowing the oil to rise through the solution in very fine drops of definite size. The change in concentration was again measured by taking the drop number before and after treatment with a known number of drops. The principle of this altered method will be easily understood from a description of the apparatus used in a third series of experiments, in which mercury in the form of fine drops was used as the adsorbent (Fig. 10).

A solution was placed in the vessel, CDE, and drops of mercury from A and B allowed to fall through the solution for some hours, the head of mercury being maintained nearly constant. The mercury collected in E and, as the drops coalesced, the surface was reduced and the adsorbed substance liberated. The constriction at F was provided to prevent diffusion of this released substance backwards into C. It was found that the equilibrium was attained, *i.e.*, that the drops had adsorbed the maximum amount of solute, if they took about six seconds to reach F. As in the previous experiment, it was necessary to know the size of the drops to permit calculation of the total adsorbing surface. To accomplish this, a greased plate was moved rapidly across the mercury jet just above the level of the solution in C, and the drops were thus kept separate and could be counted. A number of drops were collected, cleaned and weighed; from this total the weight of one drop, and consequently its volume and surface area, could be calculated. In carrying out an adsorption experiment, the total weight of mercury which had passed through the solution was also determined; its volume divided by the known volume of one drop gave the number, N , of drops, and $N \times$ (surface of one drop) was accordingly the total adsorbing surface. To find the concentration of the solution in C before and after

adsorption, surface tension measurements by the drop method were again employed. The rest of the procedure was as previously described, *viz.*, a σ - c curve was determined, from which the concentration of the solution for a given c , and the value of $\frac{d\sigma}{dc}$ for a given c , could be taken directly.

The results obtained with various solutions show that dissolved substances can be divided into three classes :—

(1) Those of complex constitution and high molecular weight, *e.g.*, sodium glycocholate, Congo red, methyl orange, sodium oleate, which show adsorption 20—100 times larger than that calculated from the formula.

(2) Simpler compounds, like AgNO_3 , KCl , BaCl_2 , CuCl_2 , which show adsorption 5—10 larger than the theoretical figure (these cases may be complicated by dissociation and ionic adsorption, which will be referred to later).

(3) Caffeine and aniline, which show practical agreement with theory.

It must be added that in the class (2), and still more in (3), the excess u was so small that very little reliance can be placed on the experimental figures.

In view of the fundamental importance of the Gibbs-Thomson formula, and the magnitude of the discrepancies between the figures calculated from it and the experimental results, it is of obvious interest to inquire, to what causes the deviations may be due. The first point to be noticed is that the complex substances which exhibit them most markedly form, at least at higher concentrations, colloidal and not true solutions. It is, therefore,

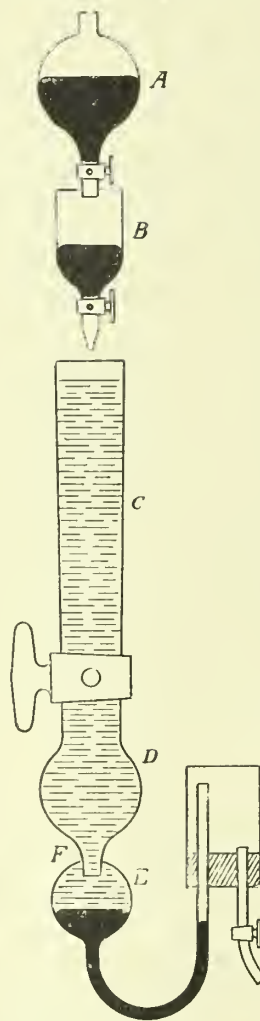


FIG. 10.

very probable that they may form gelatinous or semi-solid skins on the adsorbent surface, in which the concentration may be very great. There is a considerable amount of evidence to support this view. Thus Lewis finds that, if the thickness of the surface layer be taken as equal to the radius of molecular attraction, say 2×10^{-7} cms., and the concentration calculated from the observed adsorption, it is found, for instance, for methyl orange, to be about 39 %, whereas the solubility of the substance is only about .078 %. The surface layer, therefore, cannot possibly consist of a more con-

centrated solution of the dye, which is the only case that can be dealt with theoretically, but must be formed of a semi-solid deposit.

A large number of the dyes which behave abnormally when adsorbed exhibit photo-electric properties in the *solid* state, *i.e.*, they emit negatively charged particles when illuminated with ultra-violet light. Adsorbed layers of these dyes show a similar behaviour and are therefore probably composed of solid substance.

The existence of semi-solid pellicles or membranes on the surface liquid-air has also been proved for a number of substances other than dyes, *e.g.*, for albumin by Ramsden, for peptones by Metcalfe, and for saponins by Shorter. In forming these the substance may even be profoundly modified—thus the albumin becomes insoluble when adsorbed in the surface.

The explanation just suggested does not apply to substances which are very soluble and which are in true solution at all concentrations. There is, however, the possibility that the Gibbs-Thomson formula may only be approximate even for such solutes. When we examine the method of derivation of the formula, we find the assumption made that the energy of the molecules of solvent in the surface layer is not altered by the adsorption, *i.e.*, by the increased concentration of molecules of solute. But we have seen before that when a solution and its solvent are separated by a semi-permeable membrane, a motion of the latter takes place; this proves that the energy of the molecules of solvent on the two sides of the membrane is different. A further possible source of error is the alteration of the compressibility of the liquid forming the surface layer. Owing to the high concentrations which may occur in this layer, such a change is probable, since the compressibility of solutions is lower than that of the solvent. But we know from a previous chapter that a lower compressibility means a higher intrinsic pressure, *i.e.*, a greater mutual attraction between the molecules, and we also know that various other properties of a liquid alter with its intrinsic pressure. In Gibbs' method of obtaining the adsorption formula all these changes and their possible effect on the balance of energy are neglected, and it is, therefore, quite possible that the formula may be inaccurate, although it is very difficult to estimate the magnitude of the error involved.

On the other hand, the experimental tests of the adsorption formula so far described are not free from objections. From what has been said, it will be clear that the dissolved substance, if it is to afford an accurate test, must fulfil the following conditions:—

(1) It must be of simple and definite chemical constitution and form true aqueous solutions of simple and definite character;

(2) It must be non-volatile and sufficiently soluble in water under the conditions of the experiment; and

(3) It must cause a large decrease of surface tension even in extremely dilute solution.

(To be continued.)

PERSONAL AND OTHER NOTES.

DR. JOHANNES MULLER, Professor of Physiology and Bio-Chemistry, and President of the Bio-chemical Institute at the Academy for Practical Medicine at Düsseldorf, has been appointed Professor of Experimental Physiology at the Medico-Chirurgical College of Philadelphia.

Dr. Günther Bugge, successor to Dr. A. J. Kieser, has been elected deputy editor of the *Zeitschrift für angewandte Chemie*.

Miss Jessie Y. Caun, chief of the chemical department at Rockford College, Rockford, Ill., has obtained an appointment as instructor of chemistry at the State University of Illinois (Champaign).

Dr. Artur Loos, President of the Laboratory at the agricultural experimental station at Augustenburg, has received the title of Professor.

The citizens of Hamburg have granted 12,500 marks for the purpose of providing the additional buildings of the chemical Government laboratory with apparatus and chemicals.

The Institute of Chemistry issues particulars of the proceedings of the Council, in which it is recorded that the building fund has reached a total of £17,056 15s. 8d. The finance and house committee report that a further £1,000 will be required for furnishing and other improvements tending to reduce the subsequent cost of maintenance. The Council has further considered the question of the position of chemists in India, and Sir Alexander Pedler has appeared before the Royal Commission on the Public Services in India. The commissioners took evidence chiefly with reference to the views of the Council of the Institute on the recruitment of professional chemists for Government service, and in what respect the Institute could assist the Government in securing chemists for official appointments. It was made clear in this respect that the Institute was prepared to hold examinations in India for any candidates whether Indian or European who had complied with the regulations as to training. A special Council meeting was held on June 12th to consider the question of bringing the work of the Institute more prominently before the public. Four lectures will be given during the winter months. A History of the Institute 1877—1914 is now issued, which records that the Institute had its origin in a meeting held on April 27th, 1876, to discuss the organisation of the chemical profession, Prof. Abel being in the chair. A committee was appointed to confer with the Chemical Society with regard to a scheme for establishing an organisation of professional chemists. Ultimately it was decided to form a new Association independent of the Chemical Society. The first officers of the Council, with Prof. Frankland as president, were elected in 1877. It may be noted that the Organisation Committee proposed that fellowship of the Chemical Society should be one of the conditions of membership of the Institute, and that the Chemical Society should be empowered to nominate five members of the Council of the Institute. These proposals were not adopted.

REVIEWS OF BOOKS.

"THE NATURE OF ENZYME ACTION." By W. M. Bayliss. Third Edition, Revised and Enlarged. LONGMANS, GREEN & Co., London, 1914. Pages 180 + viii, including Index. Chapters X., with 7 Illustrations. Price 5/- net.

THE continued discovery of new facts in connection with this important branch of experimental science has rendered it necessary to revise certain parts of this important monograph, which has met with considerable success in its past editions. The author rightly claims that the importance of the action of surface phenomena or adsorption in the action of enzymes (which he has advocated from the first) has been justified and is now generally recognised.

There can be no doubt but that the demand for this work will continue in its new edition, and that it will still remain one of the most important contributions to the important series of monographs to which it belongs.

"INTRODUCTION TO THE STUDY OF ORGANIC CHEMISTRY." By H. T. Clarke. LONGMANS, GREEN & Co., 1914. Pages 484 + iv. Price 6/6.

The author claims that in writing this work he has dealt chiefly with the principles and structural unity of his subject. The book has been written to meet the new syllabus (1912) of the lower examination in organic chemistry in the Board of Education examinations in science and technology. The needs of students in medicine have also been covered in the larger type of the book. This volume certainly serves its purpose and will be classed among the best of the rapidly increasing number of general text-books at the disposal of the student.

"CHEMISTRY AND ITS BORDERLAND." By Alfred W. Stewart. LONGMANS, GREEN & Co., London, 1914. Pages 314 + ix, including Appendices and Index. Chapters XV., with 11 Illustrations and 2 Plates. Price 5/- net.

This semi-popular work has the advantage of being written by one who can claim a special knowledge of the subject reviewed. From a general point of view the chapters dealing with the methods of chemical research and its organisation are specially interesting. The value of the influence of an experienced investigator on the young mind is rightly emphasised—"that a student can acquire a grasp of research methods much more rapidly and with fewer mistakes if he conducts his first experiments with a more experienced investigator at his back to suggest simpler methods and more rigid tests than a beginner would be likely to think of for himself."

The author considers that at the present day, as far as the major part of our industries are concerned, "there is no inducement for an investigator to enter a factory." We do not think that this is

correct in a great many cases; nor that the British Association information (1902), that only some 1,500 chemists are employed in our factories, would apply at the present time. In an appendix a scheme for the improvement of research conditions is discussed at some length. The author seemingly confuses "teaching research" with the possibility of teaching the *methods* of research, which is a proposition of a different order.

Anyone wishing to enter this profession would do well to carefully study this work, and, without accepting all the suggestions made by this author as to the possible conditions under which chemists may find themselves working, there is much which will command the attention of all those interested in the future of chemistry.

"CLEAN WATER AND HOW TO GET IT." By Allen Hazen. CHAPMAN & HALL London. Pages 196 + xii. Illustrated. Price 6/6 net.

This volume is concerned with the methods adopted in the cities of the United States to secure a satisfactory supply of water. It is illustrated by series of interesting photographs of filter beds, reservoirs, etc. It will be read with interest by those on this side of the water who are interested in this subject.

BOOKS, ETC., RECEIVED.

"Complex Ions in Aqueous Solutions," by A. Jaques, D.Sc., F.I.C. Pages 152 + vi. Longmans, Green & Co. 4/6 net.

"Preliminary Report on Uranium, Radium, and Vanadium," by R. B. Moore and K. L. Kithil. Bulletin 70, Bureau of Mines, Washington, 1913.

"Inflammability of Coal Dust," by Messrs. Fraser, Hoffmann and Scholl. Bulletin 50, Bureau of Mines, Washington, 1913.

"Mining and Treatment of Lead and Zinc Ores in the Joplin District, Missouri," by C. A. Wright. Technical Paper 41, Bureau of Mines, Washington, 1913.

"Approximate Melting Points of Commercial Copper Alloys," by H. W. Gillette and A. B. Norton. Technical Paper 60, Bureau of Mines, Washington, 1913.

"The Use and Misuse of Explosives in Coal Mining," by J. K. Rutledge. Miners' Circular 7, Bureau of Mines, Washington, U.S.A., 1913. Pages 52, with 8 Illustrations.

"Monthly Statement of Coal Mine Fatalities in the United States, November, 1913," compiled by Albert H. Fay. Bureau of Mines, Washington, U.S.A., 1914. Pages 23.

"Monthly Statement of Coal Mines Fatalities in the United States, July, 1913," compiled by Albert F. Hay. Bureau of Mines, Washington, U.S.A., 1913. Pages 19.

"Rules for Mine-Rescue and First-Aid Field Contest," by James W. Paul. Miners' Circular 15, Bureau of Mines, Washington, U.S.A., 1913. Pages 12.

ENGINEERING NOTES.

By R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

Permeability Tests for Paints.

Mr. A. M. Muckenfuss, in a report under the above title to the American Society for Testing Materials, discusses various methods of testing and various comparative standards of "weight," and "volume permeability" in the case of paints and varnishes spread on surfaces of wood veneer, cement, cloth, wire mesh and paper.

As to his definitions, "weight permeability" is the weight of moisture vapour passing through a coat of paint or varnish in 24 hours divided by the weight of the coat itself. "Volume permeability" is the weight of water vapour passing through the coat in 24 hours divided by the volume of the coat when dry on the given surface; it is easily deducible from the "weight permeability" by dividing the latter by the specific gravity of the dried coating.

The tests are made by coating a disc of one of the above-named materials about $7\frac{1}{4}$ ins. diameter with the material to be tested, and the average weight of this coat after the siccatives, etc., have dried out is usually about 10 gms. Above this screen is a weighted dish of calcium chloride, and the screen is subjected to artificial rain and sunlight by means of a rotating garden spray and a mercury vapour lamp of high candle-power at short range. The coat is subjected to these special weathering tests in a cylinder of about 7 ft. in height and 4 ft. in diameter; descriptions of the tests are carefully given, and the results show unexpectedly large contrasts between the various materials used. Cements often broke down in two days, implement paints in three, varnishes in five days, and some outdoor paints could be examined for 100 days or more.

Heat has a great effect on permeability and osmosis takes place more readily towards the outside air than the reverse way.

Porosity is to be in no way confounded for the purpose of these researches of Mr. Muckenfuss with permeability. The experiments are readily modified to discover the permeability of various coatings to obnoxious gases, acids and acid fumes, etc.

As regards moisture they are in very satisfactory agreement with the feeling of long experience with the more commonly known and used materials experimented with.

Fuel Briquettes.

The United States Bureau of Mines published some time ago their Bulletin No. 58 on Fuel Briquetting, covering eight year's investigations into this subject up to July, 1912.

The Bulletin, of course, is chiefly concerned with briquetting in the U.S.A., and some of the most interesting portions of it have but little application in this country. Lignite in America is fairly plentiful—is a fairly low-grade fuel and moist, its commoner varieties briquet easily without the addition of any binder; tests in the Bulletin show that this fuel in briquetting loses 20% to 30% of moisture on briquetting and gains 30% to 50% in calorific value, giving a reduction in bulk with a considerable heating increase. Luckily or unluckily this is of only academic interest to us who have hardly any lignite to deal

with; peat, however, which obtains in both countries, can be similarly dealt with, with equally beneficial results. The case that is most interesting in this country is the briquetting of anthracite dust and sub-bituminous dust, and this requires an artificial binder; pitch, the most obvious, and thermally about the best, has the great disadvantage that it produces a smokily burning briquet, and the other binders are apt to be anything but waterproof if not smoky. A very full and interesting description of various briquetting plants is given in the Bulletin and, judging by the general completeness of these plants, it is pretty evident that the briquetter is not likely to succeed easily if he is financially a small man. A very complete series of physical tests is given for dropping, tumbling, crushing, absorption density and weathering of the briquettes, and those answering all these tests satisfactorily should handle and last well. The tests and the manner of taking them is fully set forth. Returning again to binders, the merits and demerits of pitch have already been pointed out, and for rapid firing in the commercial, as opposed to household, sense pitch is the cheapest and best binder. The binders which best fulfil household uses, however, such as cereal binders and "sulphite pitch," while smokeless, are not waterproof, and manufacturers generally say that separate waterproofing is prohibitive. Pitches high in free carbon and low in the products usually distilled off before pitching are unsuitable as being too hard for most binding purposes. Pitch, which becomes brittle in water at 55° F., is usually found best. Numerous other binders have been tried, but only those mentioned above have so far shown real commercial vitality.

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, *Chartered Patent Agent,*
Queen Anne's Chambers, Westminster, S.W.

16728/13. A. E. BERRY and A. BOAKE ROBERTS & Co., LTD. **Rubber.**

To effect coagulation and prevent oxidation and darkening of the colour of rubber latex, a freshly prepared solution of sulphurous acid is added directly to the latex.

16838/13. J. ALEXANDER. **Briquettes.**

A briquette, according to this invention, consists of fine coke compressed in a briquetting press with oil gas tar as a binding medium.

17579/13. C. FOHR and E. KLEINSCHMIDT. **Briquettes.**

A process for the manufacture of briquettes comprises melting and spraying pitch through nozzles whereby it is converted into extremely fine pitch dust on cooling, and incorporating said pitch dust with the material.

3546/14. DETTIFOSS POWER Co., LTD., and J. H. LIDHOLM. **Calcium Cyanamide.**

In the production of calcium cyanamide from calcium carbide and nitrogen in a rotary tube furnace, nitrogen supplied under pressure is used as a driving agent for circulating the gas contained in the furnace.

13382/13. J. G. BYROM. **Catalysers.**

Catalysers for use in the hydrogenation of oils and fats are prepared by treating the solution of a soluble salt of any metal with the solution of an alkali silicate and drying the precipitate.

6617/14. J. LUTJENS. **Sulphuric Acid.**

A process of automatically maintaining constant the reaction in sulphuric acid manufacture in the chamber or tower system, is characterised by the operation of the device which regulates the supply of nitric acid, saltpetre solution or the like, being controlled by a thermometer in the chamber or tower, whereby when the temperature in the chamber or tower rises, the device is automatically closed or throttled, whilst when the temperature falls, it is opened.

7272/13. K. TAKEDA. **Dressing Ores.**

In a process of dressing ores by causing particles of useful minerals to attach themselves to bubbles of gas, the pulverised ore is first intimately mixed with an aqueous solution of an alkaline carbonate and with an oil and is then mixed with a heated acidified fluid, the gas being then generated.

7648/13. W. CROWTHER. **Dyeing.**

For washing, sterilising and drying wool, hair or rags, or for dyeing and drying wool, hair, rags, cotton and other fibres or woven fabrics, compressed air is introduced into a vessel beneath a perforated false bottom so that it passes up through the liquor to stir up and agitate the contents. At the same time, a stream of liquor is forced from below the false bottom on to the upper surface, thus giving a double circulation. The liquor is then removed and the material aired and sterilised by blowing through it heated compressed air.

7700/13. NAAMLOOZE VENNOOTSCHAP ALLGEMEENE UITVINDING EXPLOITATIE MAATSCHAPPIJ. **Albuminous Compounds.**

Protein is obtained in solution by mixing fish, which has been well boiled and washed, with calcium hydroxide and water, and allowing the mass to stand at normal temperature. The lime is subsequently removed by passing carbon dioxide through the mass, with or without the addition of ammonia.

7813/13. A. C. BUNTING. **Food for Animals.**

Brewers' yeast is mixed with the meal or flour of maize or other suitable grain, pulse or cereal, and baked. Sugar or other sweetening or flavouring agent may be added.

7953/13. C. V. THIERRY. **Zinc Extraction.**

Zinc vapours escape from a reduction furnace through narrow joints or openings in the walls or floor of the furnace, in which openings they condense, so that liquid zinc escapes outside from the joints or openings, and may be collected in cups or grooves provided on the furnace. The joints or openings may be formed by omitting the mortar in making the walls or floor of the furnace, or narrow slot-like openings may be made through the furnace walls.

13751/13. DEUTSCHE GOLD- UND SILBER SCHEIDE ANSTALT, VORMALS ROESSLER. **Hydrogen Peroxide.**

A process for rendering stable solutions of hydrogen peroxide containing caustic alkali, consists in admixing with these solutions as anti-catalytic agents, small amounts of soluble magnesium salts which do not give rise to the formation of sludge.

14105/13. S. B. BILBROUGH and J. FREW. **A new or improved Process for Extracting Tannin from Bark, Wood, and other Vegetable Materials, and Apparatus or Plant for carrying out said Process.**14220/13. M. WASSERMANN. **Paint.**

A process for producing a paint suitable for metal, wood and other building surfaces consists in sulphonating

train or fish oil with strong sulphuric acid and treating the sulphonated product with suboxide of copper and adding a suitable quantity of litharge.

14428/13. C. VAUTIN. **Ore Treatment.**

The method of dressing an ore consists in introducing the powdered ore into a vertical column of fluid, such as air or water, rotating rapidly about a vertical axis in a suitable vessel, removing the heavier particles from the centre of the bottom of the vessel and removing the lighter particles from a point nearer the periphery of the rotating vertical column of fluid or away from the centre of the bottom.

14778/13. A. PHILIP. **Oil.**

An oil for use as fuel consists of a solution of up to 8% or thereabouts by weight of naphthalene in crude or heavy petroleum oil otherwise untreated.

14939/13. F. E. GALLAGHER and H. S. MORK. **Sugar.**

In the production of sugar from cellulosic material by the application of sulphite liquor as hydrolizing agent, waste sulphite liquor to which has been added a proportion of an acid, is employed.

15048/13. F. E. MATTHEWS and H. J. W. BLISS. **Improvements in the Manufacture of Dihalogen Paraffins.**15049/13. W. H. PERKIN and F. E. MATTHEWS. **Improvements in the Manufacture of Butadiene and Homologues thereof.**15316/13. R. DODD and H. B. P. HUMPHRIES. **Vegetable Ivory.**

Semi-plastic substances resembling ivory, vegetable ivory, horn and the like are manufactured by the action of aluminium sulphate, with or without an acid, upon a water extract containing approximately the proteins and soluble matters of the soja bean. The precipitate or coagulate so obtained is then treated in well-known manner.

15679/13. J. F. CARMICHAEL and F. GUILLAUME. **Sulphuric Acid.**

In a process and plant for manufacturing sulphuric acid in which the gases pass in series vertically through a number of independent vertical chambers, each alternate chamber is left empty while the others are provided with packing or filling.

18113/13. SALPETERSÄURE - INDUSTRIE - GESELLSCHAFT G.m.b.H. **Nitric Acid.**

In the concentration of dilute nitric acid by means of a hygroscopic agent and by treatment with a counter-current of steam or gas containing a large proportion of steam, part of the separated and concentrated nitric acid is returned to the mixture.

24135/13. H. BUNZEL. **Gelatine.**

In the preparation of bones for the manufacture of gelatine, the bones macerated with hydrochloric acid are treated with sodium peroxide or percarbonate or with the corresponding per compounds of other alkalies or of the alkaline earths.

4564/14. C. T. KINGZETT, E. P. KINGZETT and THE SANITAS COMPANY, LTD. **Disinfecting.**

An apparatus for disinfecting by means of formaldehyde consists of a vessel adapted to contain liquid and having fixed therein a block of permanganate of potash.

8917/14. ACTIEN-GESELLSCHAFT FÜR ANILIN-FABRIKATION. **Process for the Manufacture of Aminoanthraquinones or their Derivatives.**

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

Iodine Number of Linseed and Petroleum Oils.

The determination of the iodine number of linseed and petroleum oils according to the Hanus method has been considered by the American Bureau of Standards of the Department of Commerce and the results published in Technological Paper, No. 37.

Each of the three factors, weight of sample, time of absorption and amount of Hanus solution, was studied for a series of burnt linseed oils and petroleum oils. The results produced by variation of one of the factors, the others remaining constant, are reproduced graphically. Variations of weight of the raw linseed oil show that a constant volume is obtained for weights of the oil up to 0.25 gm. Beyond this value, the iodine number decreases with increasing weight. For burnt linseed oils, the range of weight over which the iodine value is constant decreases with increased burning of the oil. Petroleum oils, on the contrary, approach a constant value when 0.6 gm. or more of the sample is taken. Varying the time of absorption from five to sixty minutes shows that the reaction approaches a maximum in about ten minutes. Thereafter, absorption is slow, and a few minutes one way or another have little effect on the value obtained.

When the amount of Hanus solution is varied from 20 to 75 c.c. the results indicate that the oil with the highest iodine number does not require the greatest excess of iodine to reach maximum absorption value. The effect of temperature on the value obtained is more marked for burnt linseed oils than for boiled or raw oils. The results, as a whole, indicate that concordance is obtained only when a prescribed procedure is followed with exactness. To obtain comparable results, a standard procedure should be followed in which the limits are strictly defined. This is particularly the case with burnt linseed oils.

Useful Synthetic Product.

Although a great number of new synthetic products are constantly brought out, there are only comparatively few of them which attain a prominent commercial position. One of the most promising inventions of recent times is a material called "Faturan." It is manufactured on the Continent and used on a large scale as a substitute for horn, ivory, ebony, amber, and many other expensive substances. Faturan is obtainable in round bars of different sizes as well as in plates or sheets, according to the purpose it is meant to fulfil. It lends itself to sawing, drilling, turning, or any similar treatment, and takes a beautiful polish. One of its chief charms is the fact that it can be had in any desired colour or shade, from the palest cream to jet-black, including shaded and striped or veined effects. In order to manufacture bent articles, the material has to be soaked in boiling water for some time and then placed in cold water. Its use in one form or another is practically unlimited, and being non-inflammable and non-hygroscopic, it is even more useful than some of the more expensive materials which it is meant to replace.

Turpentine Oil.

Experiments on the utilisation of tree stumps and mill-waste by distillation have been conducted recently in Canada and in the United States with wood obtained from the Douglas fir. By steam distillation the best result obtained was 4.1 gallons of turpentine oil per cord of wood, weighing 3,800 lbs. By destructive distillation the average yields obtained per cord in two test runs were wood alcohol (100% strength), 2.3 gallons; turpentine oil, 1.6 gallons; other oils, 3.8 gallons; tar, 15.3 gallons; acetate of lime (80% strength), 62.9 lbs.; charcoal, 800 lbs. It is stated that as these proportions of turpentine and other oils, and tar, are lower than those commonly obtained from waste wood of the Norway and long-leaf pines, the use of Douglas fir wood on a large scale for distillation purposes is not anticipated.

Production of Hydrogen under High Pressure.

Professor Bergius, of Hanover's process of producing hydrogen by the action of superheated water, under very high pressure, on iron in a closed vessel is receiving attention. Large volumes of hydrogen are thus produced in a short time. It can be obtained at a pressure of more than 1,400 lbs., so that the expensive compressing of the gas is dispensed with. A further advantage of this process is that it is carried out at a temperature of between 200 to 300° C., a temperature at which the hydrogen produced does not contain impurities.

Guano Discovery in Peru.

The Peruvian Government Information Office in Paris has issued an account of the discovery of a new guano island in the Pacific, based on telegrams just received from Peru. From this account it seems that a Peruvian named Rairez, an owner of a trading vessel on the Pacific, has reported to his Government the existence of a guano island a mile and a half in length, on which live great numbers of guano-producing birds. He called upon the Government to take possession of the island in the name of Peru and recognise him as the discoverer, awarding him the statutory 40% of all the guano recovered from the island.

Synthetic Camphor Concern in America.

A company financed by Philadelphia chemists, who have succeeded in producing camphor synthetically from a turpentine base, is now being formed with the intention of beginning manufacturing operations with a daily output of 2,500 lbs., equal to about one-fourth of the present consumption of gum camphor in the United States. The promoters of this concern state that they are making this synthetic product at a cost far below the prices asked for the natural gum. It is said to have been used with satisfactory results by a celluloid manufacturer in Newark, N.J.

Manufacture of Glass in Hungary.

The cheapness of the natural gas in Transylvania and the facility with which it may be conducted from the source

at Kisszarnas to Tordo has caused a firm to establish glass-works at the latter place. The demand in Hungary for plate glass is supplied by importations from abroad, and the Hungarian Ministry of Finance has undertaken to furnish this new glass factory with 75,000 cub. metres of gas daily at a very low price in order to facilitate the establishment of a new industry. The enterprise will be financed by the Commercial Bank.

Mica and its Uses.

The recent discovery of mica deposits on the north banks of the Oliphant's River, Transvaal, is likely to have some effect upon the mica market. Mica at present comes principally from India, the chief producing districts being those of Hazaribagh, in Bengal, and Nellore, in Madras, but Canada and the United States also produce small quantities. Of recent years the uses of mica have largely increased. For insulating purposes it is without an equal, and is used in large quantities in modern high-tension electrical appliances. The spread of wireless telegraphy has also largely increased the demand for mica, while it has varied uses as transparent fire-resisting material. Waste mica is used in the manufacture of lubricants and as an absorbent of nitro-glycerine in the preparation of certain explosives. The present value of mica ranges from about £100 to £3,000 per ton according to the size of sheets of clear mica produced.

Turpentine Industry in India.

A Government notice from Simla mentions that the turpentine industry of this country is about to receive a fresh impetus. It appears that the subject was seriously discussed at a recent conference held at Dehra Dun, the Government forest station in the Himalayas. It was announced that improved French machinery had been installed at Bhawali in the United Provinces, and that it had also been decided to improve the machinery at Lahore in the Punjab. Steps have been taken to standardise the production, so that it is hoped by the Government authorities that within the next few years Indian demands will be fully met by local production.

Camphor Industry in Japan.

The camphor monopoly of the Department of Finance in Japan has been conducting experiments with the view to producing camphor of commercial value from leaves and branches of the camphor tree. Experiments have been carried on for some time, but on too small a scale to ascertain the commercial possibilities of the process. An experimental station has been established in Fukuoka Prefecture, in a camphor forest on Mount Tempai. This forest has an area of $35\frac{1}{2}$ acres, and contains 58,000 trees planted in 1908. The young leaves of the camphor tree are distilled, and the distillate is then analysed to obtain the percentage of camphor produced. The experimental station has a capacity of 2,000 gallons of distillate a day. Four hundred pounds of leaves are required to produce 317 gallons of distillate, four distillations are made every day, and the distillate is examined every three hours to obtain the percentage of camphor. The residue is then used for fuel. Distillates have been prepared from the leaves of young and old trees, from large and small trees, and from the branches of the trees as well. It is expected, as a result of these experiments, that a great impetus will be given to the production of commercial camphor in Japan.

L. M.

CONSULAR REPORTS.

Swedish Inventions.

H.M. Chargé d'Affaires at Stockholm reports that two companies have been working successfully for about a year on the practical application of two Swedish inventions which promise to be of considerable importance. One company is manufacturing a soil fertiliser from the air by a new secret process which is not electrical, and is said to be very much cheaper to operate. The second company is the Aktiebolaget "Abies," Westervik, which is engaged in the manufacture of sacking, matting, ropes, etc., hitherto made of jute, out of wood-pulp cellulose. The rolls of cellulose as they come from the wood-pulp factories are cut into very narrow long strips and then spun into thread. It is claimed that sacking can be produced at less than half the cost of jute sacking, and that the price would be more steady. Some samples of matting, sacking, and rope made by the above-mentioned process may be inspected by United Kingdom firms at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall Street, E.C.

Chemicals in Japan.

The following information is from the report by H.M. Commercial Attaché at Yokohama on the trade of Japan in 1913, which will shortly be issued: The imports of industrial and pharmaceutical chemicals into Japan are on a large scale and amount to about £1,500,000 yearly, the principal items being those used in the match, paper, glass, and soap industries. As these industries have been progressing during the year, business in heavy chemicals may be said to have been good, the value of the importations of soda ash, caustic soda, chlorate of potash and phosphorus amounting to over £450,000. With regard to chlorate of potash, it is of interest to note that the works near Lake Inawashiro, in the north, are now said to be producing on a large scale, but it is difficult to get statistics as to the actual output.

There has been a large advance in the imports of acetate of calcium, viz., from 5,272,000 lbs. in 1912, valued at £30,000 to 9,100,000 lbs., valued at £56,000, in 1913. This came entirely from America. It is said that the increase is accounted for by the progress made in the manufacture of acetic acid in Japan, which is probably correct, as the importation of this latter article dropped to less than £200. In the imports of glycerine there has been a falling-off from £80,000 to £66,000, and this may become more accentuated when the manufacturing plants (which have recently been started) get into full swing. The chief purchasers are the military authorities and the Monopoly Bureau, the latter using it for the preparation of tobacco. About 60% of the supplies came from the United Kingdom and the balance chiefly from Germany.

Chilean Nitrate Industry.

Writing from Valparaiso, the American Consul gives some facts regarding the growth of the Chilean nitrate industry. He says the nitrate business in that country is in a prosperous condition and new works are being opened with a promise of better results than in 1913, when production increased about 5,000,000 Chilean quintals—a quintal equals about 101 lbs. This progress in the Chilean fields has, it is said, caused a demand for modern machinery, and it is suggested that this will pay the attention of manufacturers.

New Method of Gum Collecting in New Zealand.

The office of the United Kingdom Trade Commissioner for New Zealand reports that a company has been formed with a capital of £30,000 to carry on dredging operations for the recovery of the kauri gum which exists in large quantities in many of the swamps in the Northern Peninsula. A gold-dredger has been purchased and altered to adapt it for gum dredging, and operations are expected to commence this year.

If this new method of gum collecting proves successful, it is anticipated that similar operations will be started in other parts of the swamps in the north, which cover many thousands of acres.

Chemical Trade of Mannheim.

The bad state of trade affected this branch but little in the year 1913, which was, at least, as good as the preceding year in spite of the dearth of money. Nevertheless returns left much to be desired and did not always correspond with the cost of the raw materials and coal. The exports to European countries and other parts of the world were equal to 1912. Towards the end of the year exportation to Turkey and the Balkans was again possible. The new United States tariff caused a short lull in the trade with that country, but more active business is expected.

New Process of Refining Olive Oil.

A new olive oil distillery with what is said to be a new process for refining the raw product, which was started last year, is in operation at Nice, France. In a report regarding this process to the United States Commerce Department, the following comments are made:

The owners of this distillery claim that the process is entirely mechanical and that the oil refined by this new method is of a higher grade than that obtained by filtering through cotton wool and filter paper. On the other hand, those who employ the old methods claim that the refining of olive oil cannot be accomplished by mechanical means alone, but that a chemical reaction is necessary for its purification. They have offered a premium for an analytical process by which refined or so-called deodorised oil can be detected. So far no one has been able to determine by chemical analysis which process has been used.

MARKET REPORTS.

LONDON.—During the period under review the markets in chemicals have been subjected to extraordinary influences which could not fail to cause a temporary suspension of business. The rapidity, however, with which the disturbing circumstances and difficulties have been overcome, is certainly very satisfactory, and although several sections of the markets are still more or less demoralised, there are others which have entirely recovered from their momentary stupor and are more active than for many months. It was quite unavoidable that the complete dislocation of the foreign trade in chemicals and raw materials resulted in a remarkable uplift in values, as the excited scramble for supplies and the possibility of future scarcity supplied the necessary stimulus for prices to soar upwards, yet, even this movement has quite lately been checked to a certain degree, and in any case, our markets are in no worse position than many others and in a far better one than most of them. The question of the moment for the chemical manufacturer is the *probable effect of the complete*

annihilation of the German export trade with Great Britain and her colonies on our own industries. Without undue optimism it may safely be asserted that there was never a more favourable chance for developing those branches of the industry which used to be considered the monopoly of the Germans, such as the manufacture of aniline dyes, synthetic indigo, certain fine chemicals, etc. It is to be hoped that the manufacture of these will shortly be established in full swing here or greatly extended.

The position in the fertiliser section is most difficult to gauge, as there are many conflicting influences to be taken into account. The shipments of nitrate from Chili threatens to cease, although this threat is not taken too seriously by the trade, but on the other hand, the German consumption of nitrate for agricultural purposes must diminish, if the war should last some time. Refined nitrate is sold at high prices owing to the large demand from the manufacturers of explosives. Sulphate of ammonia is also very uncertain. Although the competition of German makers is at present removed, and the home production will, necessarily, be reduced, the prices have shown no tendency to improve. Gray 25% quality, London prompt, is nominally quoted at £10 7s. 6d. Tar products have suffered acutely through the disturbances caused by the war, more particularly through the Proclamation, making trading with the enemy illegal. Pitch makers are anxiously wondering whether South Wales will require sufficient quantities of the material to make up the loss of the export trade. The present business is almost at a standstill, so that the values are not tested. The stocks of toluol are nearly exhausted, as the production before the war had been carried on at a reduced scale. An article of great interest is represented by carbolic acid (60%), the price of which touched 2s. 6d. per gallon a few days ago, but which has since gone back to 2s.—2s. 3d. Crystals have also firmed up, being quoted at 9½d.—10d. per lb. The supply of these is inadequate to meet the increased demand for hospital and Government purposes. The inquiry for benzol was very active, causing a quick jump of values to an unjustified high level. Meanwhile, more natural conditions supervened with the result that 50—90% benzol is again obtainable at 1s.—1s. 3d. per gallon. Solvent naphtha has been scarce for prompt delivery, but the present quotation, e.g., 1s. 2d. per gallon naked, is not the highest touched during the last few weeks.

MANCHESTER.—Owing to the cutting off of supplies from Germany several heavy chemicals have been almost unobtainable, although the consumers were prepared to pay fancy prices. A strong demand for caustic potash has been experienced from soap manufacturers who were unable to satisfy their requirements. Bleaching powder has been dealt in largely at £10 per ton, hard wood. Alum has risen considerably, £8 2s. 6d. being paid for ground alum in bags. The prices of cream of tartar, tartaric acid and citric acid are firming up almost day by day.

LIVERPOOL.—The disturbed condition of the markets, due to the war, does not prevent an active trade in certain articles which, in the past, have been principally obtained from the Continent, but which will henceforth be made in British factories. In consequence of the great scarcity in caustic and carbonate of potash the values have advanced enormously, caustic potash, 88—90%, realising £50 per ton. The same price is asked for 90—92% carbonate. Tartaric acid is firmly held at 1s. 9d., citric acid at 3s. 9d.—4s., and oxalic acid at 6½d.

GLASGOW.—Excited buying of articles which threatened to become scarce caused a dangerous uplift in value, raising them in some cases by 100%. Business under these condi-

tions is very difficult, and a few weeks must elapse before the trade can assume a more normal course. The daily advance in prices makes quotations unreliable.

Metal Markets.

LONDON.—The serious financial difficulties due to the war threw practically every section of the metal trade in a state of chaos, from which it can only slowly emerge. The condition of the copper market is quite uncertain, and as no official dealings take place, prices cannot be anything but nominal. The usual statistics and trade returns are not available, so that there is no guide to the state of the market. Refined copper is neglected, electrolytic being offered at £70—£72 per ton ex warehouse. According to the latest news from the United States the leading copper producers are agreed to restrict production. British manufacturers of copper tubes and sheets are busy with Government orders. Tin is reported to be remarkably scarce in New York, where high prices are quoted. The local trade was very restricted and export business suffered temporary suspension, but a speedy revival is confidently expected. Prices of tinplates are firm. Pig-lead presents an uncertain appearance, as it is most difficult to gauge the prospective supplies owing to the disturbed shipping traffic. The manufacturing trades are kept active on Government account. Spelter is very scarce, but there is every hope of better supplies in the near future. Hard spelter realises up to £30 per ton.

CONTINENTAL FINANCIAL ITEMS.¹

The Deutsche Kunstleder Aktien Gesellschaft, at Kötitz, near Cosweg (artificial leather manufacturers) have resolved to raise their capital by 600,000 marks to 3,000,000 marks, in order to exploit a new invention and enlarge the works.

Berlin.—A new company of rubber and celluloid goods manufacturers has been formed with a capital of 20,000 marks. The managers of the concern, which bears the English title of "The Premier Waterproof and Rubber Co., Ltd., m.b.H.," are H. W. Hasseberger, of Manchester, and C. Otte, of Charlottenburg.

Prague.—A company has been incorporated with 400,000 kr. for the purpose of erecting wood-preservation works. At the head of the "Holzimprägnierwerke G.m.b.H." is Hugo Schwarz, Director of the Anglo-Austrian Bank in Vienna.

Russische A.G. der Cellulosefabrik "Waldhof," at Pernau, a concern which is almost entirely financed by Germans, made a net profit of 1,176,044 roubles for 1913. The dividend will be 4%.

The producers of alcohol for agricultural purposes at Budapest propose to erect a spirit refinery under the firm of Zentral-Spiritusraffinerie A.G., which will be outside the cartell.

Kalle & Co. A.G. will raise its capital by issuing shares of a value of 1,500,000 marks, which will be taken up by the Höchster Farbwerke. In addition to this an issue of 5% debentures of a value of 2,000,000 marks will be made.

Antwerp.—Under the style of "Produits Chimiques de Flandre" a new company with a capital of 1,000,000 francs has been registered, with the object of converting tar products obtained from Rombachs' coking works at Zeebrugge.

Köpenick.—Nitritfabrik A.G. made a net profit of 96,699 marks only (122,039). Their dividend will be reduced from 6% last year to 4½%. For some years the company distributed a dividend of 16%.

The Bayerische A.G. für chemische und landwirtschaftlichchemische Fabrikate, at Heufeld, made a net profit of 196,013 marks (121,332) which permits the distribution of a preference dividend (in arrears since 1907—8) and payment of a balance remaining from the dividend for 1906.

Deutsche Gelatinfabrik, at Höchst, made a net profit of 473,484 marks (533,212).

The dividend will be 14% (16%), leaving a sum of 53,484 marks to carry forward.

CONTINENTAL NOTES.

The annual report of the Chamber of Commerce of Basel contains an interesting reference to the chemical trade of that district during 1913. It appears that the year under review saw a general decline in activity and profits which had been abnormally high during the previous twelve months. The production of synthetic indigo is now an important branch of the chemical industry, and the initial difficulties which presented themselves appear to have been quite overcome. The prices of all kinds of acids have been very high in consequence of increased demand for agricultural and other purposes (such as the manufacture of explosives, etc.). The paint and colour industry has been suffering from fierce competition, but the chemical-pharmaceutical section has had a rather satisfactory year, although the Balkan troubles crippled the export trade with the countries affected.

The consumption of artificial silk in the district of Crefeld, the centre of German silk weaving, has fallen off during 1913. The silk goods manufacturers are principally users of nitro-cellulose artificial silk, while plush weavers prefer viscose silk. The prices of both kinds fluctuated between 11 marks to 14.50 marks for the nitro-cellulose product and 11.50 to 13 marks for viscose. The manufacturers of artificial silk supply the consumers without the aid of merchants or dealers.

Seventeen of the leading Russian sugar manufacturers have formed a cartell in order to regulate prices and stimulate export trade. In consequence of the last two large sugar crops in Russia the manufacturers have not been able to place their surplus abroad, with the consequence of the home market becoming flooded.

The cellulose factory belonging to Prince Henckel von Donnersmarck, at Stahlhammer, near Lublinitz, has been partially destroyed by fire. The damage is 200,000 marks.

NEW COMPANIES.

RADIUM SALT CO., LTD.—Capital, £35,000 in £1 shares. Objects: To carry on the business of chemists, druggists, manufacturers, of and dealers in salts, acids, alkalis, chemicals, drugs, medicines, medicaments, chemical and surgical preparations, and to adopt an agreement with the No. 3 Syndicate, Ltd.

J. E. TERRY, LTD.—Capital, £1,000 in 950 shares of £1 each and 1,000 shares of 1s. each. Objects: To take over from W. Brocklehurst certain secret processes and recipes, to carry on the business of manufacturing, wholesale and retail chemists, druggists, etc.

SMOKELESS FUEL SYNDICATE, LTD.—Capital, £35,000 in £1 shares. Objects: To carry on the business indicated by the title and that of colliery proprietors, smelters, &c.

¹ Recent events may modify these particulars.



THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY W. P. DREAPER, F.I.C.

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

VOL. III. No. 10.

OCTOBER, 1914.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
" " Abroad 8s. " "

Chemical Products and the War.

APART from the formation of Board of Trade and other committees it is evident that there is considerable activity in the chemical industries in the direction of increasing the home and export markets in certain products which have in the past been manufactured elsewhere. The reason of this has not always been due to inability to manufacture, but to entirely different causes, such, for instance, as the effect of cut-throat competition between German and Swiss manufacturers.

The displacement of markets and uncertainty at the seat of manufacture have undoubtedly led firms in this country to try and regain, or start, the manufacture of certain of these products, and it may reasonably be anticipated that, once started, such manufactures will continue after conditions have once again become reasonably normal. Other things being equal, it is probable that this country, Italy (which has made surprising advance of recent years in chemical matters owing to the capabilities of their industrial chemists), Switzerland and America will secure, and retain to a certain degree, the chemical trade of Germany and Austria.

It will be remembered that under pre-war conditions, Dr. Duisburg claimed that the commercial organisation of scientific endeavour had raised the German chemical trade to an unassailable position. That she was capturing the trade in coarse chemicals as she had done the fine ones. That whenever chemical and chemical engineering problems were concerned they feared nothing. The combination of banking facilities, system of factory management and scientific thoroughness in detail was undoubtedly one which our manufacturers found especially formidable. Through past and early success in the manufacture of (say) aniline dyes, leading firms in Germany achieved the proud position of showing balance sheets in which such items as buildings, plant, etc., were written down to possibly one-fifth of the original cost, and, as a consequence of the success of the past organisation on strictly scientific lines in its broadest sense, they had almost unlimited credit for further extensions at, say, 5 per cent. Backed by past experience and an internal organisation which obviously must

take years to emulate by those starting *de novo* or working under less favourable conditions, this picture undoubtedly represented the condition of affairs at the opening of the war.

If these products are to be manufactured under English trade conditions, not during the reign of panic conditions, but as a permanent venture, it will need a strong pull and a pull together by the interests which are the equivalent to those enumerated above, be they what they may. A good deal of loose talk in the past about the effect of the patent law (discussed elsewhere in this number from the point of view of the war) has been beside the mark, when it is remembered that the only protection granted to Germany in this respect was that given to the one who got to the Patent Office first. The race was to the strong: to the one best organised. It would be idle to fight such conditions, which represent modern scientific warfare (in this particular direction) at its best, with the tools of the 1870's. A close inspection will, however, confirm the statement made to the writer some five years ago by a director of one of the largest German aniline dye manufactories, that not 10% of their products or output was protected by patent rights, but by organisation along German lines. Equally vague has been the statement that the want of free alcohol has been at the root of England's failure. A list of the dyes actually requiring alcohol in the manufacture indicates that this could not be the case. With alcohol at the cost of rainwater and free trade in the patents of other countries the result would have been much the same in the absence of that spirit of scientific and deliberate correctness and efficiency, and the peculiar self-effacement of large numbers of scientific workers, who, directing operations in the works at practically the wages of superior workmen have achieved such results in the world-wide endeavour on the part of Germany to outclass all other nations in this special branch of industry.

It may not be out of place to consider the equivalent of such conditions and the possibility of meeting them in this country. If the technical colleges which are spread over this country can supply men—who while lacking the advantage of a university education in its fullest sense, are drawn

from the ranks of the low middle class, or even scholarship men from the working class, whose aim is to become superior scientific workmen in its industrial sense (at a wage of, say, one hundred and fifty to two hundred a year), then such conditions are possible. Such men properly trained occupy a position equivalent to that of the dispenser in his relation to the physician. If such conditions can be met *under English conditions*, the technical colleges will have served their purpose. They must be judged by the quality of the output, not by their college buildings or special laboratories, for these are not carried away by the students when they leave to undertake industrial work. The technical college as the lodge-gate to the factory has a distinct and ever widening future, and with its essentially practical course does not ultimately compete with the institutions devoted to the more theoretical side of the subject with departments of scientific research and highest training. The supply of well-trained chemical workers must be of the greatest use in the endeavour which will come to meet the continental conditions of manufacture, and at the same time show a profit on the capital expenditure required for plant and working expenses.

Any panic measures on our part to set up competition on jerry-built lines will assuredly fail to achieve their object, which is continued working when normal conditions once more obtain. For this reason it may be argued that existing manufacturers should be encouraged to extend their output rather than that attempts be made to start new organisations which will have to meet conditions of competition (apart from Germany and Austria) which will still be severe. It is, therefore, reassuring to see that the Board of Trade Committee consists of manufacturers as well as scientific and collegiate members, and that as a consequence it will not be likely to advise any steps being taken which may ultimately, through their failure, lead to an unsatisfactory position. It will be remembered that the final factors which must lead to a *commercial* success are many; some of them obscure. Many of the products are only manufactured in small quantities. They represent a kind of retail-wholesale business which has been altogether foreign to the special instincts of the English manufacturer, who likes to deal in thousands of tons. It is idle to think that the mere waving of a wand will ensure success. It may be that the chief effect of the war will be educational rather than direct. Only time will show.

From the scientific point of view further organisation is undoubtedly essential. The Science Guild seems to have settled down to the arm-chair stage of existence, or it might have done much at the present juncture. There is, so far as we know, no concerted attempt to deal with the displacement of chemical activities due to many going to the war, the dislocation of the work of others, and the sudden call for the aid of scientific and technical knowledge on the part of these departments or large firms dealing in the requisites of war. Apparently two chemical cases have come before the Comptroller for

permission to work foreign patents during the war. The other cases down are chiefly mechanical or electrical.

SOME INTERESTING PUBLICATIONS OF THE U.S.A. GOVERNMENT.

By A. H. MAUDE, A.I.C.

IN the June issue of this journal, under the above title, reviews were given of two U.S.A. Government publications, one on the density of alcohol, the other on mineral wastes. With a view to showing further the character and wide range of these publications, other bulletins will be described. The first is entitled "On the Colorimetric Determination of Iron with Special Reference to Chemical Reagents," by H. N. Stokes and J. R. Cain (Bulletin of the Bureau of Standards, Vol. 3, No. 1, p. 115). It is perhaps unnecessary to enlarge on the importance of this subject, as probably every analyst has had to face the problem of determining minute traces of iron in one material or another, that element being a common impurity in so many chemical substances.

This bulletin, commencing historically, points out that of the various methods proposed for the colorimetric determination of iron, sulphocyanide, ferrocyanide, salicylate, etc., none but the first has been much considered, and the paper restricts itself to investigation of this method.

The first important fact noted is that, owing to the colourlessness of the ionised ferric sulphocyanide, the intensity of the colour of the solution is extremely dependent on its composition and concentration, and, as has been pointed out by Tatlock, great advantage in accuracy is obtained by extracting the ferric sulphocyanide from the aqueous solution with ether and comparing the solution with a standard ethereal solution. Still, the authors found that this method was not reliable, owing to the reduction of the ferric salt to the colourless ferrous salt. This they remedied by the addition of potassium persulphate, but found that it oxidised the sulphocyanide radical to a slight extent; they subsequently, however, discovered that the addition of mercuric sulphocyanide formed double salts, which prevented this oxidation without appreciably diminishing the sensitiveness of the method.

Though it is not proposed here to give a complete description of the procedure ultimately found by the authors to be best, the mention of a few of the more interesting features of the process will give the reader an idea of the method. The authors state that Amyl alcohol with a small addition of ether is a better solvent for the extraction of ferric sulphocyanide than pure ether, and that it is important that the iron should be concentrated into a small bulk free from any substance which may affect the result. The method of concentration varies according to the impurities present, but the final step is the precipitation of the iron as ferric hydroxide together with a quantity of hydrated manganese dioxide (this latter to make the precipitate sufficiently bulky to be easily dealt with on the filter). They lay great stress on the importance of purifying the iron from other metals and give schemes for doing this in most cases, but have failed to find a satisfactory method for the removal of tin; precise details are also given of the methods to be used with various commercial substances, such as acids, alkalis, salts, etc. As an indication of the sensitiveness of the method the figure obtained for a sample of sulphuric acid may be quoted, viz., out of four determinations the lowest figure was 0.0000066 and the highest 0.0000074 gm. per 100 c.c.

THE SUPPOSED ASSIMILATION OF SUGARS BY YEASTS IN THE ABSENCE OF FERMENTATION.

By WILLIAM A. DAVIS, B.Sc. (LOND.), A.C.G.I. (Rothamsted Experimental Station).

THE epoch-making researches of Pasteur led to the general acceptance of the view that the ordinary phenomena of fermentation—the formation of alcohol and carbon dioxide—are inseparably connected with the growth and development of the yeast. In 1860, indeed, Pasteur wrote (*Ann. Chim. Phys.*, 1860, 58, 398), “il ne se forme de globules de levure de bière sans qu’il y ait présence de sucre où d’une matière hydrocarbonée et sans qu’il y ait fermentation de ces matières.” Since 1897, however, when Buchner’s first experiments on fermentation without yeast cells were published, the mechanism of fermentation has been resolved into a series of enzyme changes. Nevertheless, although it is now generally recognised that it is possible to bring about fermentation by enzymatic material such as Buchner’s *zymase*, in the ordinary processes of fermentation effected by yeast a rough proportionality exists between the amount of fermentation and the growth of the living organism. At the same time, a small proportion of the sugar which is fermented appears to be “assimilated” by the growing yeast and transformed into cell tissue. The generally accepted view is that fermentation and assimilation go hand in hand, so that, as taught by Pasteur, there can be no assimilation (or growth of the yeast) unless fermentation also takes place.

Recently, however, a considerable amount of work has been published tending to show that a sugar can be assimilated by a yeast which does not ferment it, and that in such cases growth of the yeast can occur at the expense of the sugar without the latter undergoing fermentation. In the present article an account will be given of the principal evidence which has been brought forward in support of this view and the fundamental errors which underlie it will be discussed. The nature of these errors is particularly instructive and throws an interesting light upon the possibility of highly skilled investigators being led astray in work of this kind unless the very greatest care is exercised in controlling the purity of the chemical substances they deal with and in checking purely qualitative experiments by rigid quantitative methods.

The best known worker who takes the view that assimilation of a sugar can occur in the absence of fermentation is Lindner, who has published a series of papers dealing with the action of numerous yeasts on different sugars (Lindner and Saito, *Woch. Brau.*, 1909, 27, 509; 1911, 28, 61 and 561; *Biochem. Zeitsch.*, 1913, 56, 163; *Woch. Brau.*, 1913, 30, 589). From numerous experiments he draws conclusions which on a *a priori* grounds would in themselves seem highly improbable:—

1. Maltose is of all sugars by far the most easily

assimilated by all yeasts, and best lends itself as a carbohydrate food for these and similar organisms. This is true even of yeasts, such as *S. Exiguus*, which do not contain the enzyme maltase and, therefore, do not ferment maltose.

2. Dextrose and laevulose are far less readily assimilable than maltose by yeasts in general, although as is well known they are readily fermented by these.

3. Sugars are frequently easily assimilated even when they are not fermented.

4. Some sugars (although this case is rare) are fermented by yeasts which do not assimilate them: thus, for example, *S. Exiguus* readily ferments dextrose, laevulose and cane sugar, but does not assimilate them.

In a dissertation published in 1910 (*Woch. Brau.*, 1910, 27, 525) Rose also maintained that *Endomyces Magnusii*, a maltase-free organism which does not ferment maltose, grows far more vigorously in a solution of maltose than in a solution of dextrose, which it rapidly ferments. In a similar manner Kita (*Centr. Bakt.*, 1912, Abt. 2, 35, 388) stated that a new species of yeast obtained from “*Ikaskiokara*” (salted cuttle-fish) also assimilates maltose but not dextrose.

Now all these observations clash with the general theory, which now seems well established, that the assimilative or fermentative activity of organisms is due to the enzymes they elaborate. We have, in the examples cited above, instances of maltase-free organisms which are apparently capable of directly assimilating maltose but incapable of utilising as food the simpler sugar dextrose, which is the product of the action of maltase on maltose, and is itself said to be fermented by these yeasts forming carbon dioxide and alcohol. Moreover, these observations stand in striking contradiction to the general theory of food assimilation which has been established by physiological research in recent years, particularly by Abderhalden and his school. According to this theory, food material has in all cases first to be broken down by enzymes into its simplest components or “*Bausteine*,” which are then taken up by the different cells or tissues and synthesised afresh according to their requirements. A carbohydrate, for instance, such as starch or maltose, would according to this view not be assimilated directly as such, but would be first broken down by enzymes, the starch yielding as a product maltose, which in turn would be resolved into two molecules of dextrose before being actually absorbed.

An important series of observations has recently been published by A. J. Kluyver¹ (*Biochem. Zeitschr.*,

¹ A more detailed account of these experiments, from which the account here given has been taken, is published in a monograph,

1913, 52, 486), which give a clear explanation of the apparently anomalous results obtained by Lindner and the other workers referred to above. Kluyver shows, in the first place, that when various maltase-free yeasts are grown in solutions of ordinary so-called "pure" maltose (Kahlbaum's) using Hayduck's nutrient solution (asparagine and the necessary salts), Lindner's results are confirmed: such maltose gave 20—60 times as much growth of yeast (measured by the dry weight formed) as occurred with solutions of dextrose. *When, however, the maltose was purified several times by recrystallisation, the difference between the nutritive value of maltose and dextrose disappeared, the purified maltose being no better as a source of food than dextrose, and in some cases of maltase-free organisms less so.* Kluyver attributes, probably with justice, the remarkable assimilation observed when using Kahlbaum's maltose to the presence in this of small quantities of protein or nitrogenous food which is more suitable than asparagine (or peptone) as a source of nitrogen for certain yeasts. He gives analyses showing that such maltose contains 0.22% of protein matter. The writer can fully support Kluyver's contention as to the impurity present in Kahlbaum's maltose. Not only does it contain protein matter (probably derived from the diastase used) but invariably also from 5 to 15% of dextrin and small quantities of dextrose. No sample of supposedly pure maltose that the writer has yet met with on the market has, when carefully examined, proved to be anything like a pure substance.

There can be little doubt, from the observations recorded by Kluyver, that for many yeasts asparagine and peptone are not suitable sources of nitrogen to favour the growth of those yeasts in presence of dextrose, although ordinary brewers' yeasts (*S. cerevisiæ*) grow perfectly well in presence of asparagine and this sugar. For the former yeasts ordinary yeast-water is, however, a perfect nutrient medium, and when experiments are made with this solution, dextrose is found to be "assimilated" even more readily than pure maltose by the same yeasts which had formerly shown a contradictory behaviour in presence of asparagine.

It must here be emphasised that Kluyver does not draw the conclusion from his experiments that maltose cannot possibly be assimilated by maltase-free yeasts; indeed, the experiments he quotes, valuable as they are, would not enable him to go so far as this, and there is little doubt that he himself still considers that certain sugars, even when they are not fermented, may still serve as food-stuff for the living yeast (compare "Biochemische Suikerbepalingen," pp. 41 and 45). That this is certainly *not* true in the case of several maltase-free yeasts is shown by very numerous experiments which the writer has carried out during the past three years. During the systematic employment of maltase-free yeasts for estimating maltose according to a method recently suggested (Davis and Daish, *J. Agric. Sci.*,

1913, 5, 437), it has been necessary frequently to control the purity of the cultures of *S. Marxianus*, *S. Exiguus* and *S. Anomalous* used (for which we have been indebted to the kindness of Dr. A. H. Hutchinson) by fermenting solutions of known quantities of highly purified maltose, mixed with cane sugar or dextrose, and verifying whether such cultures, whilst fermenting away every trace of the latter sugars left behind every trace of maltose. *This has invariably been the case.* Even when considerable quantities of sugar have been fermented and a large growth of yeast has been formed in consequence, there has been no sign whatever of any maltose being assimilated or removed. Thus, for example, the following experiments may be quoted:—

Maltose taken = 0.3704 gms; cane sugar. = 0.2000 gms. Fermented 31 days at 25°.

After Fermentation with	Maltose remaining in solution.	% Maltose left.
<i>S. Exiguus</i> ..	0.3712 ..	100.2%
<i>S. Marxianus</i> ..	0.3736 ..	100.8
<i>S. Marxianus</i> ..	0.3734 ..	100.7

Fermentation of the cane sugar or dextrose is usually complete after about 14 days; if the solution be then left in the incubator for a further period of 3 to 6 weeks (in some cases they have been left even longer) there has never been the least indication of any of the maltose being subsequently "assimilated" or destroyed. Within the limits of experimental error the whole of the maltose (99.5 to 100.5%) has been quantitatively recovered. Although an abundance of maltose is present in the solution as well as a large growth of yeast, the latter, even when in the throes of starvation, cannot make use of the sugar it is in contact with, simply because it does not possess the necessary mechanism—the enzyme maltase—to break down the complex sugar to the simpler form, dextrose, which it can attack. This is a striking fact. Here is a case, certainly, in which the organisms cannot adapt themselves to the straitened conditions of their environment and elaborate an enzyme which is usually present in the commoner yeasts, and is necessary for the decomposition of the disaccharide maltose.

Whether *in all cases* fermentation and assimilation go together cannot be definitely decided yet, but certainly in that of the maltase-free yeasts we have worked with there is no assimilation of maltose when fermentation does not also occur. For both changes the preliminary breaking down of the maltose to dextrose by the enzyme maltase is necessary. It must here be emphasised that practically all experiments hitherto made on assimilation have been carried out with entire disregard to the quantitative side of the question. Such crude qualitative processes as Lindner's "Kleingärmethode," in which a decision as to the behaviour of the yeast is arrived at by observation of small quantities of the material under the microscope should be entirely abandoned in work of this kind. As emphasised by Kluyver, independently of the risk of infection, it is extremely difficult to decide in many cases, when the action is feeble, whether any fermentation occurs or no.

"Biochemische Suikerbepalingen" (E. J. Brill, Leiden, 1914, pp. xi. + 223). This is in Dutch, and therefore less accessible to the general worker.

Reliance upon this method has led Lindner to the highly improbable conclusion that yeasts exist which are capable of fermenting exclusively complex carbohydrates such as inulin, or inulin and trehalose, without being able to touch the simpler hexoses of which these polysaccharides are composed. The use of the Einhorn-flask in such cases is not much better.

The only safe method of ascertaining whether assimilation or fermentation occurs is to carry out quantitative fermentations with exactly known quantities of the sugar taken, inoculating the sterilised solution with pure cultures of the yeast and following the course of the action during considerable periods (from 1 week to 1 month) by quantitative estimations of the sugar remaining and of the products (alcohol and carbon dioxide) formed. In all such experiments a little yeast-water must be added to supply the essential nitrogen and phosphorus food to the yeast.

The necessity of carefully verifying the purity of supposedly pure chemicals used in such investigations cannot be over-emphasised. Neglect of this precaution has led Lindner and other workers into the gravest error. Lindner in one of his latest papers pathetically remarks how desirable it would be for

the large chemical manufacturers to exercise more control over the purity of the preparations they send out. Whilst no doubt in the case of most ordinary chemicals, both inorganic and organic, the standard of purity maintained is sufficiently high for all practical purposes, certain carbohydrates and other materials which are purified and characterised with difficulty are sent out in the form of comparatively impure substances. Such compounds should be carefully examined by each individual worker and their purity controlled before they are employed with confidence in any serious research. Not only was Lindner led astray by the impurity of his maltose in the investigations referred to above, but in another equally important field he was induced to draw the most erroneous conclusions. From a series of experiments with this substance he concluded that many yeasts and similar organisms are capable of directly assimilating atmospheric nitrogen during the process of growth. This nitrogen, as a matter of fact, was supplied in the form of an impurity in the maltose used, and when the experiments were repeated with the carefully purified sugar no such "assimilation" of nitrogen could be observed (compare Lindner and Naumann, *Woch. Brau.*, 1913, 30, 589).

VALENCY AND CHEMICAL AFFINITY.

By G. F. MORRELL, PH.D., B.Sc., F.I.C.

To obtain a true conception of the laws which dominate the workings of that mysterious and elusive force which binds atoms into molecules, and molecules into still more complex aggregates, has been one of the chief tasks of chemistry ever since it became worthy of the name of a science. The problem is fundamental, and to its partial solution in the realm of the carbon compounds must be entirely ascribed the brilliant success which has attended the efforts of chemists in treading the intricate labyrinths of the organic world and building up laboriously, but surely, compounds of amazing complexity, which it was once thought could be synthesised in the laboratory of Nature alone. On the other hand, the too frequent shelving of this problem in its profoundly more difficult aspect in the mineral world, by the retention of worn-out theories which no longer corresponded with fact, and by the invention of such terms as "molecular compound" and "water of crystallisation," which soon became meaningless names glossing over an underlying ignorance—to all this is due the comparative stagnation of inorganic chemistry, a stagnation which is none the less lamentable because, perhaps, an unavoidable phase in the development of the science.

To the ancients, who generally saw in chemical combination the creation of new matter, the forces governing this combination were of little concern, but the term *affinity* was introduced by the mediæval alchemists in order at least to give a name to that

which they did not understand, and cared still less to attempt to explain. The name, of course, presupposes the similarity of substances which interact with one another, and it is compatible with the extreme looseness of phraseology of that and the succeeding phlogistic age that the term affinity was retained even when it was recognised that dissimilarity, rather than similarity, was the criterion which determined combination. Boyle, who first clearly enunciated the distinction between elements and compounds, ascribed the formation of the latter to a mutual attraction between the elementary corpuscles of which they were composed, and decomposition was due to the greater attraction or affinity between one of the components and some external substance than between the components themselves. Boyle and his successors supposed this force of affinity to be, in the main, identical with gravity, and chemical change was, therefore, interpreted by them as the outward sign of a hidden struggle between opposing mechanical forces. The protest of Berthollet against assigning absolute values to affinity, regardless of the external physical conditions of the reaction, passed unheeded by his contemporaries, largely, however, because of his many indiscreet deductions, which came into direct conflict with the then newly-discovered law of constant proportions. To trace in this essay the fortunes of the various doctrines of affinity through the great revolutionary period of chemistry would be both tedious and unprofitable for theories based

upon purely qualitative experiments, or upon the false premises of the Dalton school, were bound in the end to fail to satisfy the increasing demands made upon them as fresh facts were brought to light.

From out of the confusion of the time there stands forth the commanding figure of the great Berzelius. Although he gave his adhesion to certain theories which are still held to be incorrect, it is surprising to find how we gradually return, after the lapse of years, to a modified form of some of the original conceptions of this brilliant thinker—conceptions which were discredited and scorned by his immediate successors. Thus the electrical theory of chemical affinity had its origin in Berzelius and his distinction between different degrees of affinity in compounds of the first, second, and third order, is strikingly reproduced in the modern theories of Werner, Abegg, and others. According to Berzelius the elementary atoms carried a surplus of positive or negative electricity, and affinity was due to the electric field set up between oppositely charged atoms. The molecules of the compounds of the first order thus produced—oxides, chlorides, etc.—might still possess an excess electric charge and could, therefore, unite with other oppositely charged molecules to form secondary compounds—acids, bases, salts, double chlorides, etc. Similarly, compounds of the third order, such as hydrates, alums, etc., were produced by virtue of the residual affinities of the secondary compounds, if one may apply a modern expression to elucidate Berzelius' views. The dualistic theory founded by Berzelius on these electro-chemical lines was, however, by reason of its narrowness, doomed to succumb to the attacks of the chemists of the French school, and it involved in its fall the theory of affinity on which it was based. Not until modern times was it destined to rise again, clothed in a new garb, and meanwhile the theory of valency had arisen and firmly established itself for good and ill as a fundamental principle of chemical philosophy. The application of Avogadro's rule to the determination of atomic weights, and the consequent revelation of the actual number of the atoms of each element present in the molecules of the binary compounds, quickly showed that a certain regularity subsisted in the number of atoms which attached themselves to the same element, and Frankland and Kekulé pointed out how the "combining powers" of the elements could be expressed as simple multiples of the combining power of the hydrogen atom. This expression of the saturation value of an atom received the name of *valency*. In the fortunate and almost unique case of carbon, the application of the new theory reaped an immediate and fruitful harvest. The assumption of the tetravalence of carbon, together with the postulation of double and treble bonds, explained, without exception, all the then known facts—the laws governing the chemical affinity of the carbon atom seemed to have been laid bare, and, although the ultimate cause underlying that affinity was still an unsolved mystery, organic chemistry was able to forge ahead into the clear light of day. Not so

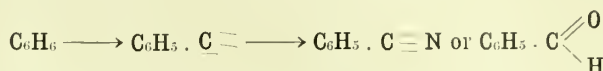
fortunate, however, was the application of the theory of valency to the other elements. It was soon found that most of them could exhibit more than one valency, that some, in fact, could apparently behave with almost any valence from one or two upwards. Thus from molybdenum were obtained MoCl_2 , MoCl_3 , MoCl_4 , MoCl_5 , and MoCl_6 and from tungsten a somewhat similar series. Manganese gave derivatives of MnO , Mn_2O_3 , Mn_3O_4 , MnO_2 , MnO_3 , and Mn_2O_7 , and, however they are constituted, they certainly cannot all be derived from divalent manganese. In face of an accumulated mass of facts of this nature, Kekulé, in order to maintain his theory of constant valency as a fundamental property of the atom, was compelled to create for inorganic chemistry a limbo, or scrap heap, to which everything was relegated which did not fit in with his artificial dogma. Dismissed, therefore, under the designation molecular compound, was everything from phosphorus pentachloride and the higher oxides to the double chlorides, hydrates, and alums. The limbo was depleted of certain of its contents by the adoption of Erlenmeyer's theory of a maximum saturation capacity and variable valency, but, since this theory was merely another expression of the law of multiple proportions, it was scarcely any advance towards a satisfying explanation of the confusing manifestations of affinity, and, moreover, there was still that troublesome class of double or complex salts, the complex ammonia compounds, and a host of others, left conveniently forgotten and buried among the *débris* of inorganic chemistry.

The ultimate test of every theory lies in the fruits of its application, and, judged from this standpoint, it must be freely admitted that the Frankland and Kekulé theory of valency has, in the great field of organic chemistry, produced such astonishing results as to ensure it a place for ever amongst the greatest theoretical achievements of chemical science. In the wide domain of mineral chemistry, however, the theory has undoubtedly failed to realise the hopes which it once raised. The other elements have not conformed to requirements which carbon, is it too much to say, has accidentally fulfilled by reason of its central position in the periodic system? But even in the case of carbon we are now assailed with doubt, and in Gomberg's triphenylmethyl we are asked to postulate trivalent carbon, whilst Nef has brought evidence to show divalent carbon in the isocyanides, fulminic acid, carbon monoxide, and acetylene. Still more recently Thorpe has shown the probability of the existence of alkylglutaconic acids containing free valencies. Hence the task of modern chemistry is twofold—to find a generalisation or law which shall account for the character of the phenomena of affinity, and, secondly, to find some explanation of its cause. Numerous efforts have been, and are being, made to solve these problems, but within the limits of this essay it will only be possible to give a brief sketch of a selection of the theories which at present hold the field. This will involve the omission of many important and fruitful suggestions by other investigators, and such

omission is due solely to the impossibility of dealing in a limited space with work which it would require a whole volume to treat of with justice.

Of the modern theories which seek to give some explanation of the character of valency, or to elucidate the laws which govern the manifestations of affinity, those of Barlow and Pope and of Werner hold prominent positions. Viewing the question from entirely different standpoints, Barlow and Pope seek to connect valency with the geometrical dimensions of the molecule, and hence with the crystalline form, whilst Werner is mainly concerned in developing, for the purposes of classification and co-ordination of facts, a more elastic system than the old rigid ideas of valency permit, a system which will embrace at once the ordinary valency compounds, and those which, though in no single property distinct from them, have, nevertheless, hitherto been left without the pale. The fundamental idea running through Barlow and Pope's theory is that the atoms occupy a definite space or sphere of influence, and, under the forces in operation, these atomic spheres pack themselves together as closely as possible, giving the molecule thereby a definite shape. A crystal is a symmetrical arrangement in space of an indefinitely large number of spheres of influence, and its geometrical dimensions are determined by the size and marshalling of these spheres. A study of substitution reveals the possibility of a geometric interpretation of valency, the simple relationship, in fact, that the volumes of the spheres of influence are proportional to the fundamental valencies. For example, in the packed assemblage of carbon and hydrogen spheres representing benzene, groups of three hydrogen atoms will be found, one from each molecule, and if one-sixth of such groups are substituted by nitrogen to produce triphenylamine, the nitrogen spheres must have three times the volume of the hydrogen spheres, or the packing will be disturbed and cannot be rendered so closely packed as before without such a rearrangement that it no longer represents the triphenyl derivative of ammonia. An assemblage of carbon spheres and hydrogen spheres of one-fourth the volume is found to simulate the axial ratios of benzene crystals, and the displacement of a hydrogen valency volume by a similar chlorine or bromine volume leaves the axial ratios undisturbed. The case of triphenylmethane is more complex. To produce it from the benzene assemblage the groups of three hydrogen atoms above referred to must be removed and replaced by the methane carbon atom having a volume four times that of the hydrogen. To do this the benzene residues will be thrust apart and to again produce close packing it can be demonstrated with models that another unit valency volume (a hydrogen atom) must be added to fill up the cavity. With triphenylamine, on the other hand, the nitrogen exactly occupied the place of the three hydrogen atoms and left no cavity. It is, in fact, a generalisation that, if the volume m is replaced by a volume $m + n$, an additional volume n must be added to conserve the marshalling. That is to say, in

ordinary chemical language, if one monovalent hydrogen atom of benzene is replaced by a tetravalent carbon, then an additional three valencies must be added, which is actually the case

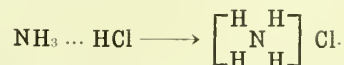


Multivalency is explained on a similar principle, the fundamental valencies being retained. If, say, the atom is trivalent, and another valency volume is thrust into the assemblage, a second valency volume will be needed to fill up the cavity formed and the original atom is now functioning with a valence of $3 + 2$. This is held to explain the valency occurring in arithmetic progression of 2: nitrogen 3 and 5, sulphur 2, 4, and 6, and so on.

The theory of Werner has, like that of Barlow and Pope, nothing to say as to the ultimate cause of affinity. Valency, which is defined as the property of attraction emanating from the centre of the atom, and symmetrically distributed over its surface, is recognised as being of two orders. The principal valency corresponds to the ordinary valency of the older theories, and has a maximum value for each element, which can be measured in terms of the saturation capacity of the hydrogen atom or by equivalence with an electron. By virtue of the *principal* valencies, compounds of the first order are formed, H_2O , NH_3 , KCl , and so forth. But the saturation of the principal valencies does not necessarily exhaust the affinity of the atoms in question. The molecule may still possess residual or *auxiliary* valencies, whereby it can attract and combine with other molecular groups, but not with radicles which can exist as independent ions. Compounds of the second order are thus formed. The actual distinction between principal and auxiliary valencies laid down by Werner is somewhat vague, but it appears that they differ in degree only, and in the final state of equilibrium they seem to merge into each other. Thus nitrogen has three principal valencies, and NH_3 is, therefore, saturated. With HCl , however, by virtue of auxiliary valencies, combination occurs.



But since all the hydrogen atoms in ammonium chloride are of equal value, and, therefore, similarly situated with regard to nitrogen, an equilibrium must be assumed

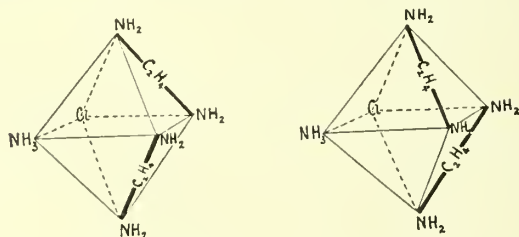


The molecules of compounds of the second order consist, therefore, of two zones around a central atom. The atoms or groups in the outer zone (outside the brackets) are ionisable, those in the inner zone are directly bound to, or *co-ordinated* with, the central atom, and do not undergo ionisation. The number of groups directly co-ordinated with an atom is known as the *co-ordination number*. This number is independent, both of the principal valency of that atom and of the valencies of the

co-ordinated atoms or groups. Its value shows a remarkable regularity, however, being in all cases either 4 or 6. This has led Werner to suggest that it may represent merely a spatial or geometric function of the central atom. In the case of carbon it is equal to the number of principal valencies, and hence valency and co-ordination compounds will be identical. The neighbouring elements boron and nitrogen have, likewise, a maximum co-ordination number of 4, and so the fluoborates, for example

appear as $\begin{bmatrix} \text{F} & \text{F} \\ & \text{B} \\ \text{F} & \text{F} \end{bmatrix} \text{H}$. In most cases, however,

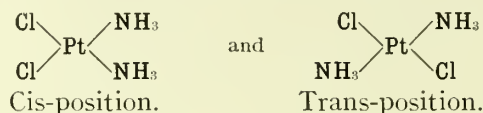
the co-ordination number is 6, and this is well illustrated by the cobaltammines, $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$; $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$; $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$; $[\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3]$. The number of ionisable radicles is 3, 2, 1 and 0 respectively, which is in accord with number of chlorine atoms in the outer zone. A further introduction of acid groups into the inner zone involves the presence of a positive ion in the outer zone, and hence we get $[\text{Co}(\text{NH}_3)_2(\text{NO}_2)_4]\text{K}$, and, finally, $[\text{Co}(\text{NO}_2)_6]\text{K}_3$, potassium cobaltnitrite. Of this latter type are also $[\text{PtCl}_6]\text{K}_2$, potassium chloroplatinate, and $[\text{Fe}(\text{CN})_6]\text{K}_4$ and $[\text{Fe}(\text{CN})_6]\text{K}_3$, potassium ferro- and ferri-cyanides. The number of ionisable groups in the outer zone depends obviously, other things being equal, on the primary valency of the central atom. Although not yet so completely worked out for the hydrates, they are also to be explained upon the same principle, *e.g.*, $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ appears as $[\text{Mg}(\text{H}_2\text{O})_6]\text{Cl}_2$. Finally, it should be mentioned that space isomerism, which is clearly theoretically possible in a system of six groups distributed around a central atom, has actually been detected among these complex salts, and Werner has, in certain cases, succeeded in isolating the optical enantiomorphs. As illustration, the compound $[\text{CoCl}(\text{NH}_3)(\text{NH}_2\text{C}_2\text{H}_4\text{NH}_2)_2]\text{Cl}$ was resolved by the fractional crystallisation of its d-bromo-camphorsulphonate.



It will be noticed in this case one molecule of ethylenediamine is capable of taking the place of two molecules of ammonia in the inner zone. Among the platinum amines cis- and trans-isomers of dichlorodiammine-platinum and tetrachlorodiammine-platinum are known (see next column).

As will now be obvious, Werner's theory is of incomparable value for the production of order out of the chaos of facts which accumulated around these so-called molecular compounds, yet, neverthe-

less, it is more of a rule than an attempt at explanation, and, as a general theory of valency, throws but



little light on such vexed questions as the structure of benzene, or the existence of free valencies in such compounds as NO, CO, C_2H_2 , and so on.

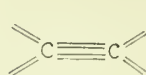
An ideal theory of valency, which shall be all-embracing and triumph over its imperfect predecessors, which, however, will have been its stepping-stones, must certainly take cognisance of the ultimate cause of chemical affinity. For these reasons the recent suggestions of so eminent a physicist as Sir J. J. Thomson, elaborating an electronic theory of affinity, are deserving of the widest publicity. Although the electro-chemical theories of Davy and Berzelius were at the time discredited, the close connection between chemical and electrical phenomena could not long be denied. It was particularly through the genius of Faraday that the constant amount of electricity associated with each unit of valency in electrolytic phenomena was demonstrated. Helmholtz, in 1881, quite definitely revived the old idea of Berzelius upon the basis "that every unit of affinity is charged with positive or negative electricity, and they can form compounds electrically neutral only if every unit charged positively unites under the influence of a mighty electric attraction with another unit charged negatively. This ought to produce compounds in which every unit of affinity of every atom is connected with one and only one, other unit of another atom . . . the chemical theory of quantivalence." Since Helmholtz's time discovery has followed on discovery, and we now know that the quantity of electricity carried by the monovalent ion is precisely the same as that carried by the negative corpuscle or electron in the cathode ray, and this suggests at once the idea that the ionic charge is due to an excess or deficiency of negative electrons. The work of Thomson has revealed the nature of the electron, and there is forced on us the recognition of the fact that even the atom of matter is a universe in miniature. What would Dalton have said to that, after his famous *dictum*: "No man can split an atom"? Upon these discoveries Sir J. J. Thomson, ten years ago, founded an electronic theory of the atom, which not only included in its scope the question of affinity, but also sought to co-relate the whole phenomena involved in the periodic law. In a communication to the *Philosophical Magazine* this year (*Phil. Mag.* [6], 161, 757-789) he has considerably developed this theory in its bearing upon affinity and valency.

Thomson regards the atom as a positively charged sphere in which the negative electrons circle in orbits which are determined by the number and mutual repulsion of the electrons and the attraction of the positive charge. The nature of the positive charge is unknown; it has, at any rate, never been separated, as have the electrons, from the atom of

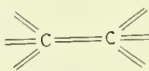
matter. Even though the atom contains equal amounts of positive and negative electricity it will produce in its neighbourhood fields of force, which will, however, diminish more rapidly than the square root of the distance, and will not be uniformly distributed around the atom. Each electron will be the end of a tube of force which, in the case of electrons in the core of the atom, will anchor them to the corresponding positive charge on the atom. But the electrons of the outer zone will be more mobile, and, if another electric system is brought up to an atom A, they will readily move into such a position that there will be attraction between A and the system, and a tube of force originating in the latter, by finding its end on one of the mobile electrons, will bind the two systems together and, at the same time, anchor the electron. When all the mobile electrons are anchored and rigid, the condition is that of chemical saturation, and, as a criterion of saturation, all the corpuscles are to be regarded as held fast by the forces acting upon them. The number of mobile electrons of the outer zone is supposed to be anything from 0 to 7, and is, in fact, equal to the number of the group in which the element is placed in Mendeleef's arrangement. It is, further, supposed that the conditions repeat themselves with eight electrons which make a rigid system exactly equivalent to the absence of mobile electrons in the outer zone. Thus helium and neon have no free electrons, sodium has one, magnesium and calcium two, carbon four, oxygen and sulphur six, and the halogens seven. If, now, these mobile electrons can only be held fast by being anchored to something external to their own atom, in the case of two atoms A and B, each of which has one mobile electron, for chemical saturation a tube of force must leave A and anchor the electron in B, and a second tube of force must leave B and anchor the electron in A. There must, in fact, always be as many tubes leaving an atom as enter it. So whereas on the old valency symbols the compound AB would be represented A—B with one bond, on the new system it becomes $A \longleftrightarrow B$, where each arrow represents a tube of force. This is of great importance, for the old theory is more rigid, and virtually assumes that if A sends a bond to B it must receive one in return also from B, whereas, on the new theory, so long as A receives a tube in return it does not matter where it originates. In ring and chain compounds the difference is specially noticeable, and we obtain a formula for benzene, which, whilst perfectly symmetrical, abolishes the difficulty of the fourth valency, and shows a carbon linkage quite different from ethane and ethylene (see next column).

To return for a moment to the distribution of electric forces due to the electrons, we find that, in the case of two atoms each containing one mobile electron, two hydrogen atoms, for example, it corresponds to that represented diagrammatically in Fig. 1. In the case of an atom having seven electrons, for example, chlorine, this is equivalent to a stable ring of eight, less one negative electron, which, so far as the electric field is concerned, is the

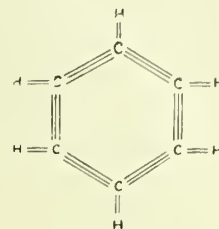
same as the presence of one positive electron. This atom may, therefore, function as the receiver of



Ethylene.



Ethane.



Benzene.

seven tubes of force or as the originator of one tube of force, that is, as possessing either seven electro-positive valencies, or one electro-negative valency. Combined with hydrogen, with its single negative valency, the distribution of force is represented by Fig. 2.

Obviously the union between atoms exerting opposite valencies will be firmer than between atoms exerting valencies of the same kind, just as

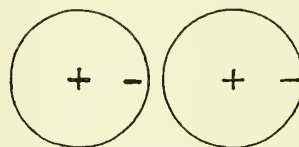


FIG. 1.

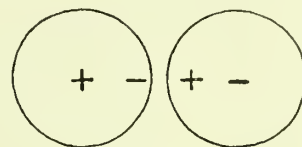


FIG. 2.

the force between the electric doublets arranged as in Fig. 2 is greater than in Fig. 1. In a similar way a ring of six mobile electrons is equivalent to eight rigid ones, and two positive electrons, that is, an electro-negative valency of two. Each atom can, therefore, exert a positive or a negative valency, the sum of which is eight. This is reminiscent of Abegg's valencies and contra-valencies, but differs in that whilst on his theory both can be brought into play at once, on this view the atom can exert one or other, but not both simultaneously. Thomson also points out that the number of corpuscles required to form a rigid outer ring will probably be influenced by the number of corpuscles in the core, that is, by the atomic weight, and hence the sum of the positive and negative valencies for elements with atomic weights above 40 need not necessarily remain fixed at eight.

The development of the theory with regard to ionisation, and the formation of hydrates and complex compounds, is particularly interesting. In the case of combination between elements at the extremes of the periodic classification, as hydrogen and chlorine, the electric forces may be sufficiently large to tear the corpuscles out of the positive atom and heap them on the negative one. This process is termed *intramolecular ionisation*, and compounds are accordingly divided into two types, those in which there is a tendency for it to occur and those in which the elements are less strongly contrasted (elements in the centre of the periodic system, the carbon compounds, etc.), and the forces conse-

quently insufficient to tear out the electrons. In the former case the valency considerations become eventually similar to those on the old theory, for the removal of an electron from the hydrogen atom to the chlorine takes with it one of the tubes of force, and leaves only one, corresponding to the one valency. But it must be observed that the molecule as a whole has now become an electrostatic doublet, and will exert much greater forces on another molecule, especially if it also has a tendency to a similar electric condition, than if both were neutral. Hence there will be a considerable molecular affinity between molecules of this class, which finds expression amongst inorganic substances in the formation of hydrates and double salts, for, as we have seen, it is precisely in compounds of strongly contrasted elements that the tendency for molecular ionisation is greatest. With the carbon compounds the contrast is lacking, and so molecular compounds are few. An abnormally high specific inductive capacity in the gaseous state, or, in other words, departure from Maxwell's law, $K = \mu^2$, should be indicative of intra-molecular ionisation, and it is found that precisely those compounds, which are known readily to form molecular compounds, H_2O , NH_3 , HCl , C_2H_5OH , all possess abnormal values for K . On the other hand, CO_2 , CS_2 , CH_4 , H_2 , O_2 , N_2O , and C_6H_6 have normal specific inductive capacities, and parallel with this is the absence of molecular compounds in these cases; "benzene of crystallisation," for example, is unheard of." Closely connected now with the property of intra-molecular ionisation is the dissociating power of a solvent. Molecules such as H_2O or NH_3 , consisting of atoms widely separated in the electro-chemical series, are of themselves able to effect the transfer of electrons from atom to atom, and if they become, as above suggested, attached to another molecule AB , where the tendency for intra-molecular ionisation is perhaps less, they facilitate it by increasing the capacity of the system, and eventually, in the limiting case of AB , in solution in the water, entirely separate or dissociate it into the charged ions A and B . As an actual instance of intra-molecular ionisation induced by the proximity of charged molecules, copper sulphate might be quoted. In the anhydrous salt intra-molecular ionisation is probably extremely slight, but in $CuSO_4 \cdot 5H_2O$ the blue copper ion has been formed by the transfer of electrons owing to the influence of the five water molecules. The Cu and SO_4 are perhaps thrust entirely apart and a new equilibrium is set up between them and the other molecular doublets. Again $[PtCl_4(NH_3)_2]$ is not ionised, but if another molecule of ammonia is added one of the chlorine atoms becomes charged and, in solution, separates as an ion $[PtCl_3(NH_3)_3]Cl$, and with six ammonia molecules all the chlorine is ionised, probably by the removal of electrons from the platinum atom $[Pt(NH_3)_6]Cl_4$.

This brief summary of Thomson's views may be concluded by a reference to unsaturated compounds. A molecule containing unsaturated, or, according to the hypothesis, unanchored electrons, can exist

when the work required to separate an atom—or break a tube of force—is inconsiderable in comparison with the average kinetic energy at the particular temperature, hence the real difficulty is not to explain why unsaturated compounds exist, but why others of analogous constitution are not also found; why, for example, CO does not condense to $OC:CO$, whereas CH_2 or CCl_2 at once, under ordinary conditions, give C_2H_4 and C_2Cl_4 . A reason is sought in the different electric fields produced by the oxygen atom and by the two chlorine or hydrogen atoms. If in the former case the mobility of the two free electrons in the carbon atom is reduced by the strong field, the attraction of the carbon atoms for each other will be likewise diminished, and their self-saturation rendered more stable. Hence the carbon would appear much more nearly saturated than in CH_2 or CCl_2 , and CO might, therefore, exist whilst the others could not. In the strong electric field in vacuum tubes CH_2 has, as a matter of fact, been detected, and there is nothing intrinsically impossible in its existence, given suitable conditions.

The idea of electrons is still comparatively new, and the world is not yet quite familiar with the atom as a whirling storm-centre of electric force, but it is assuredly along these lines that, in the future, the problems of affinity and valency must be solved.

CURRENT LEGAL TOPICS.

By WILLIAM JAGO, F.I.C.

ONE subject so overshadows all others at the present moment that it is difficult to think, let alone write, on other topics. Beside, there is the old maxim which freely translated runs: "In times of war the voice of the law is silent." It need scarcely be said that this must not be interpreted too literally. Countries, generally, refuse to recognise that there are any rights of an alien enemy in its courts; and, therefore, such enemies have no means of legal redress against acts which they may consider legal wrongs. But for the control of its own citizens, in addition to the ordinary operations of law, there are special enactments which govern their attitude towards those against whom a state of war exists.

In the first place, trading with an enemy is forbidden. Nothing may be sold to him since such action would be a means of help and succour. Nothing may be bought from him since it is presumed such purchases would be a benefit to him and would result in affording pecuniary assistance. To the analytical chemist individually, this must be more or less of an inconvenience as much of his apparatus, and also reagents come from Germany. The first precaution will naturally be the economising of stocks already in hand. The next result must be the stimulus in the production of British manufactured articles. In instruments of precision, the

makers in this country have an honourable record, and there should be no reason why much of the trade in these should not be permanently recaptured. In glass and porcelain vessels again an effort will doubtless be successfully made to supply our own wants in the future, and possibly a fair proportion of those of other people. In the case of manufacturing chemists the difficulties of others will constitute our opportunity, and that such manufacturers will realise their chances is a matter of certainty. England at the present does an enormous trade in the coarser chemicals and this should be largely increased. In the case of fine chemicals, there is no real reason why many chemicals and drugs now, or until recently, manufactured in Germany should not be produced here.

A suggestion has been made that we have not hitherto had a sufficiency of highly trained chemists. This is largely a case of supply and demand. For a good many years, when the time has come for a boy or young man to decide on his future career in life, chemistry has offered fewer opportunities of earning with industry and average ability a modest livelihood than have other professions or businesses. The result has been that the youth himself has decided, or those on whose guidance he relies have advised him, to take up some other calling. This is perhaps more realised by the older chemists than others. In the case of lads whose natural abilities and predilections lie in the direction of chemical pursuits, one has continually, when asked for information and advice as to the comparative prospects of the chemical profession, to point out that there are greater opportunities in other directions, and in fact dissuade the young aspirant from becoming a chemist. Even now, there are many of us who know instances of men in the prime of life, who as chemists have to struggle on on a pittance, only just sufficient to keep body and soul together. With improved status for the chemist and better rates of pay from the rank and file upwards, there need be no stint of capable chemical workers in this country.

Announcement has been made that the patent rights of alien enemies have been suspended during the war and for a further period of six months. The grant of a patent is really that of a monopoly by the Crown. Obviously the Crown will not continue the advantages which a monopoly of manufacture affords to the subject of a State with whom it is at war; the difficulty is what should be done when peace relations are re-established. The suggestion of six months further suspension of patent rights does not carry us very far. It must not be forgotten that any provisional arrangements of this description must be governed by the nature of the terms on which peace is made. If we are practically unable to dictate terms, we shall have to submit to whatever conditions in this matter are imposed on us. In the case of an enemy which is essentially a manufacturing and trading nation, the enemy would almost certainly demand that all restrictions on its trade should be at once removed. It is only on the assumption that we are in the

position to exact our own conditions, that we can be sure of any six months' suspension or anything else. Subject to the foregoing proviso, some inquiry may fairly be made as to the sufficiency of the proposed time of suspension. The question of suspension is raised not only in the interests of manufacturers and consequent development of British trade, but also because the manufactured goods are required for and by the consumer. Because of this, it is essential that sufficient inducement is offered to prevail on manufacturers to find the required capital and energy in the development of such new business. As the warlike conditions continue, the demand for certain foreign manufactured goods will become more pressing, and the period of continuance of war plus six months will not recompense manufacturers sufficiently for taking up the production of these articles that previously were under the protection of patents here by aliens. It is suggested that any such period of suspension of the operation of enemy's patent rights should be at least for two years certain, and that even on their resumption at the end of that time some provision should be made for such industries as had been established in the interim.

An interesting light is thrown on this subject by the provisions in patent law dealing with the restoration of patents that have lapsed through the non-payment of fees. Prior to the Acts of 1906-07 there was very little in the way of remedy for the lapse of a patent as the result of such non-payment. If satisfactory explanations of the failure to pay in due time were forthcoming, the Comptroller could enlarge the time to a period not exceeding in any case three months. But, even then, it was provided in an action of infringement, that if the infringement took place after the failure to make the payment within the prescribed time, and before the enlargement, the Court had power to refuse to award any damages in respect of such infringement. Should a patentee fail to make a prescribed payment, whether he obtained an enlargement of time or not, his patent is void. The only remedy under such circumstances would be its revival by a special Act of Parliament. Frost in the Second Edition of Patent Law and Practice (1898) remarks with regard to such special Act that if "passed it will most probably provide protection for persons who may have used the subject-matter of the invention after the notice of the lapsing of the patent."

In the Patents Act of 1907 there are special enactments governing the restoration of lapsed patents. The only point immediately concerning us is that contained in s. 20, ss. 5, which reads as follows:—

"Provided that in every order under this section restoring a patent such provisions as may be prescribed shall be inserted for the protection of persons who may have availed themselves of the subject-matter of the patent after the patent had been announced as void in the illustrated official journal."

The remarks of Frost and also the subsequent

legislation throw some light on the problem of treatment of the users of a patent restored after having been for some time void. These do not go far enough to meet the exigencies of the present case. While after a period of suspense, due to active hostilities, a patent is restored after their cessation, there would clearly be no such thing as a remedy in damages for the user during suspension, nor would it be possible for such user to be made the foundation of an action of infringement. But protection should go much farther than this, manufacturing industries established to work the invention contained in the suspended patents should be allowed to continue on terms. Any person thus interested in an established industry should be entitled to the grant of a compulsory licence on application to the Board of Trade, the lines of procedure being similar in character to those laid down in s. 24 of the Patents Act, 1907. In granting such licence, the Court would bear in mind that the industry was established during the "interregnum" of the patent, and when the patentee was himself unable to satisfy "the reasonable requirements of the public with reference to the patented inven-

tions." As against such user the patentee might be awarded sufficient royalties to give him some return for his invention, but certainly nothing like so much as he would be entitled to in the case of a compulsory licence granted under ordinary circumstances. Presumably the owner of the restored patent would have his full rights against any user actually commenced after the date of restoration. Unless patents held by alien enemies are to be absolutely destroyed as a result of the war, there must be a recognition of the rights of the patentees at some time after the conclusion of peace. The foregoing is suggested as a means of, nevertheless, giving encouragement to the British manufacturer, which encouragement must be sufficient and generous.

As to protection outside the scope of patented manufactures, this is obviously neither the time nor the place to deal with the general problem of free trade as against protection. But with new industries created in this fashion, and to meet national requirements, it is submitted that even when war is over they should be given a fair opportunity to get well established before they are subjected to unrestricted foreign competition.

SURFACE TENSION AND SURFACE ENERGY AND THEIR INFLUENCE ON CHEMICAL PHENOMENA.

By R. S. WILLOWS, M.A., D.Sc., and E. HATSCHEK.

CHAPTER VIII. (*continued*.)

IN Lewis's experiments, although they are extremely ingenious and suggestive, most of the substances employed do not fulfil condition (1). In others, although the discrepancy between calculated and observed results is not considerable, there is a large margin of possible error on account of condition (3) being unsatisfied. Thus, with aniline the change in drop number caused by adsorption was only 1 in 465.

The sources of error indicated above were avoided in a series of experiments carried out by Donnan and Barker, which in principle resemble those made by Lewis, so that only a brief reference to them is necessary. The dissolved substance was nonylic acid, and a σ - c curve was plotted by using the drop method. The results could be reproduced with very great accuracy, *i.e.*, to a fraction of one drop in 300-500 drops. Adsorption was produced at a surface air-liquid, air being passed through the solution in bubbles of known size and number, so that the total active surface could be calculated. The bubbles, on reaching the surface, burst, so that the excess of solute carried by them remained in the surface; very effective precautions were used to prevent diffusion backwards from this portion into the bulk of the solution. With a solution containing 0.0243% the excess per square centimetre of surface was found to be 0.95×10^{-7} gm., while the excess calculated from the Gibbs formula was 0.55×10^{-7} gm.

Considering the difficulties of the experiments, Donnan and Barker conclude that they may be held to verify the formula.

CHAPTER IX.

THE investigations described in the preceding chapter were directed to one point only: the exact determination of the excess of dissolved substance in the surface layer at one particular concentration. There are, however, some further questions of great importance, the answers to which must be sought by other experimental methods. The first of these is: does adsorption lead to a well-defined equilibrium in a short space of time? the second: is this equilibrium, assuming it to exist, a simple function of the concentration?

It will be obvious from the description of Lewis's and Donnan and Barker's experiments that equilibrium is assumed to establish itself during the time of contact between the mercury or air surface and the liquid; in fact this point was checked by increasing the time and showing that the result was not affected, *i.e.*, that no further quantity of the solute was removed from solution. Experiments to decide this question had, however, been made at an earlier date by Wilhelm Ostwald. The strict definition of an equilibrium requires that it should be independent of the mass of the phases in contact; thus, a soluble substance and its concentrated solution are in equilibrium at a given temperature and pressure, and this

obviously remains unaffected by altering the quantity of either solid substance or solution. Ostwald placed a quantity of charcoal in a given volume of dilute hydrochloric acid and determined the decrease in concentration after a short time. If, then, a part of either the charcoal or the dilute solution was removed, the concentration of the latter remained unaltered, which showed that a state of equilibrium had been established.

The subsidiary question, how long this state takes to establish itself, is not nearly so easily settled, and recent investigations in particular go to prove that very complicated conditions may arise. It has been assumed—tacitly in the experiments so far described, explicitly by Freundlich and others, whose work we shall discuss below—that the time required to establish equilibrium is very short. This is no doubt true in many instances, but numerous combinations of adsorbents and solutes are known in which the first rapid change in concentration is followed by a further, quite continuous, prolonged, and by no means negligible disappearance of solute from the solution. Among the most recent results of the kind may be quoted those of v. Georgievics, who uses wool as adsorbent, and finds that equilibrium is not reached in solutions of acids and dye-stuffs in several days.

It is, of course, possible to suggest various explanations of these observations, the following being most generally accepted:—

(1) The external surface of such porous bodies as charcoal, which is in immediate contact with the liquid, adsorbs very rapidly. The internal surface, however, *i.e.*, that of the pores, can only get its supply of solute by diffusion, which is necessarily slow through the very restricted sections, and particularly so with substances of high molecular weight.

(2) The solute concentrated on the surface may form a solid solution with the adsorbent, which would necessarily be a slow process too.

(3) Chemical action between the highly concentrated solute and the adsorbent may occur. This explanation cannot be rejected *a priori* even in cases where it appears extremely improbable. Thus it is fairly definitely established that oxidation of carbon takes place when permanganate is adsorbed by charcoal.

Of course all these phenomena, if or when they occur, are distinct from and consequent on adsorption in the narrow sense of the term. At the same time, they render the selection of a point at which adsorption is complete and secondary phenomena begin at least arbitrary and tend to obscure the question of adsorption equilibrium.

On the other hand, in a sufficient number of cases a definite equilibrium is undoubtedly reached in a short time, and if we confine ourselves to these, it becomes possible to approach the second question we have put, that referring to the connection between concentration and amount adsorbed. Among the investigators who have treated this problem both mathematically and experimentally Freundlich deserves to be mentioned particularly.

We cannot give even an outline of the mathema-

tical treatment, and must confine ourselves to stating the result in the symbols usually employed, although the choice of these is not altogether happy from the point of view of mathematical clearness and elegance.

If we call—

x the amount adsorbed,

m the quantity of adsorbent in grammes,

C the concentration in the solution after adsorption, *i.e.*, the equilibrium concentration,

a and n constants (where $n > 1$) for a given solute and adsorbent,

the following relation exists between these:—

$$\frac{x}{m} = aC^{\frac{1}{n}}$$

It must be borne in mind that the two variables in this formula are x and C , and that the latter is the equilibrium or end concentration after adsorption. The formula, therefore, does not enable us to calculate beforehand what amount of solute will be adsorbed by an amount m of adsorbent.

The formula is very frequently referred to, in chemical and biological literature, as an "exponential" one. This is an error which deserves to be pointed out, as the title belongs properly only to functions in which one of the variables—in our case x and C —appears as exponent, and as such true exponential functions have very peculiar properties.

In the adsorption formula the exponent $\frac{1}{n}$ is a constant, and the equation is, therefore, that of a general parabola. If we make $n = 2$, a case which actually occurs, the formula becomes

$$\frac{x}{m} = aC^{\frac{1}{2}}$$

or, in a more familiar form,

$$x = am \sqrt{C}$$

which is the formula of the ordinary parabola.

Another form of the equation is even simpler, and is particularly useful in representing experimental results. If we take the logarithms on both sides, we obtain

$$\log x - \log m = \frac{\log C}{n} + \log a$$

In this equation the variables are $\log x$ and $\log C$. Since the expression is linear, the curve obtained by plotting $\log x$ and $\log C$ as co-ordinates is a straight line.

As the adsorption formula may be stated in the simple terms that the amount adsorbed by the unit quantity of adsorbent is proportional to the n th root of the equilibrium concentration, it is obvious that it increases with, but much more slowly than, the latter. No maximum adsorption at any particular concentration is, therefore, possible in normal cases, but a number of anomalous instances have been observed in which such a maximum occurs; in other words, the phenomenon does not follow the simple course expressed by the parabolic curve.

The experimental verification of the adsorption equation is comparatively simple, apart from certain experimental difficulties. Solutions of different known concentrations are prepared and equal amounts of adsorbent are placed in equal volumes of these solutions. Agitation of some sort is generally necessary to ensure complete adsorption. When equilibrium has been reached, the concentrations of the various solutions are again determined and represent, of course, the end or equilibrium concentrations, viz., the values of C in the formula. The differences between these and the original concentrations are the amounts adsorbed, that is, the x or $\frac{x}{m}$ in the formula—the latter, as we are at liberty to choose the (equal) amounts of adsorbent as unity. The values so obtained can then be plotted; as it is, however, not quite easy to determine the character of the curve, the principal feature of which is the constancy of the exponent $\frac{1}{n}$, it is preferable to plot the $\log x - \log C$ curve, which must be a straight line if the adsorption formula holds good.

Although the experimental technique is quite simple, it presents certain difficulties. Among these the principal one is that of obtaining concordant results with different portions of the same adsorbent. The only possible method is to use equal weights, whereas what is really required is equal surface, and even with apparently uniform substances like blood charcoal it is not certain that equal weights really have equal surfaces. The selection of suitable solutes also requires care; since very low concentrations have to be determined with high accuracy, substances must be chosen which lend themselves to such determinations. From what has been said earlier, it is obvious that complications arise in solutions of electrolytes—to which we shall refer again—and it is, therefore, necessary, in testing the formula, to select non-electrolytes, or at least substances which are very slightly dissociated.

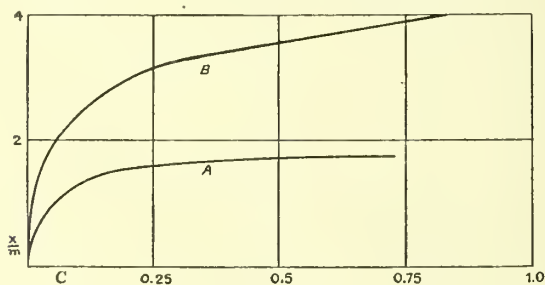


FIG. 11.

A large amount of material has been collected, especially by Freundlich, and Fig. 11 shows two very typical adsorption curves obtained by him. Fig. 12 gives the corresponding $\log x - \log C$ diagrams, which show a very good approximation to straight lines. The adsorbent in both cases was blood charcoal; the solution for A was benzoic acid in benzene, for B succinic acid in water. The characteristic feature of each curve is, of course, the exponent $\frac{1}{n}$, and it is,

therefore, of interest to compare the exponents for various substances. A number of these, also determined by Freundlich, are given in the following table; the adsorbent in all cases was blood charcoal, the solvent, unless otherwise stated, water:—

			$\frac{1}{n}$
Formic acid	..	..	·451
Acetic acid	..	..	·425
Propionic acid	..	..	·394
Butyric acid	..	..	·301
Monochloroacetic acid	..	..	·363
Succinic acid	..	..	·243
Benzoic acid	..	..	·338
Chlorine	..	..	·297
Bromine	..	..	·340
Picric acid in alcohol	..	..	·230
Benzoic acid in benzene	..	..	·416
Bromine in ether	..	..	·263

With certain dye-stuffs in water the exponent becomes as low as ·19 to ·11. Generally speaking, it lies between these figures as lower and ·5 as upper limit.

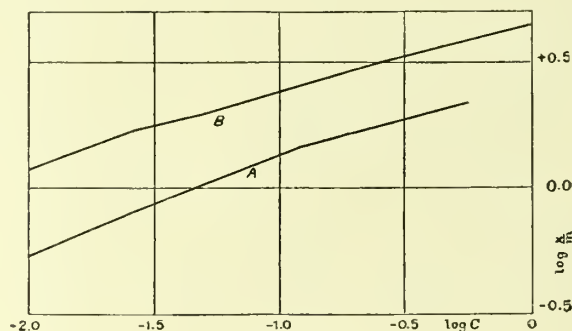


FIG. 12.

It is of interest to examine how adsorption, for one and the same substance, is affected by the adsorbent and by the solvent. As regards the former, any comparison is difficult, owing to the impossibility of determining even approximately the active surfaces in the case of two different substances like, say, charcoal and silk fibre. Leaving absolute quantities out of consideration, experiment shows that the order in which several solutes are adsorbed by different adsorbents is the same, i.e., if a substance, A, is more strongly adsorbed by charcoal than B, and this again more strongly than C, the same order will hold good if another adsorbent is used, although the numerical ratios may be different.

As regards the solvent, it is obvious on theoretical grounds that this must have a marked effect, depending chiefly on its surface tension. The increased surface concentration is the result of the lowering of the surface tension by the solute, and it is only reasonable to assume that this lowering will be more marked in a solvent with high surface tension, like water, than in solvents with lower surface tension, like the organic solvents. We should, therefore, expect adsorption to be greater in aqueous than in organic solutions of the same substance and of equal

concentrations, and this view is entirely borne out by experiment. The following figures show the relative amounts adsorbed by charcoal from solutions of equal concentration in different solvents:—

Benzoic acid in water ..	3.27
„ „ benzene ..	.54
„ „ ether ..	.30
„ „ acetone ..	.30

The surface tensions of the solvents are respectively, 75, 29, 16, 5 and 23.

The different rate of adsorption in aqueous and alcoholic solution can be demonstrated by a simple

experiment. Charcoal in sufficient amount is shaken with a dilute aqueous solution of crystal violet and renders the solution practically colourless. If the latter is now replaced by an equal volume of alcohol, this becomes deeply coloured. The explanation is simple: the adsorbed amount in equilibrium with the bleached aqueous solution is much greater than the amount which would be in equilibrium with an equally weak alcoholic solution, and a portion of it, therefore, becomes redissolved, leaving a smaller surface concentration in equilibrium with the solution.

(To be continued.)

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

CHAPTER VIII.

DEHYDRATION.

IN the detailed study of Organic Chemistry, many compounds are encountered which can be prepared either from another body by loss of the elements of water or by means of a reaction in which the elimination of water is the characteristic feature. So far as Industrial Chemistry is concerned, however, most of the products obtained by this general process of dehydration, as it may conveniently be called, result from reactions in which an alcohol or an acid is the primary reagent.

With alcohols, loss of water can occur in two ways—either with the formation of an ether or of an unsaturated hydrocarbon. Or the alcohol can be made to react with acids, or with ammonia, sulphuretted hydrogen, etc., to produce a compound whose constitutional formula differs from the sum of those of the reacting bodies by the elements of water.

Acids in a similar way may be made to yield ketones by simple dehydration, or to produce aldehydes by a reaction with formic acid in which water is eliminated.

Each of these main reactions will be considered in turn.

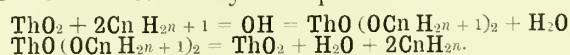
(a) *Production of Ethylene Hydrocarbons.*—Ordinary alcohol, heated to 160–170° C. in the presence of concentrated sulphuric acid or preferably syrupy phosphoric acid, is dehydrated with the evolution of ethylene. The acid in this case, however, plays the part rather of a desiccating agent than a catalyst, and the same applies to zinc chloride in this and other connections.

As true catalysts of dehydration, Sabatier—whose work on the catalysing power of oxides has already been mentioned—has shown that there are none to compare with thoria, alumina, titanium dioxide, and the blue oxide of tungsten. Thus, if a fatty alcohol be passed over thoria heated to 350–400° C. in an apparatus such as that shown in

Fig. II, decomposition takes place with the formation of an ethylenic hydrocarbon which can be condensed or collected in the gaseous state.

The efficiency of the catalyst is naturally greatly dependent upon its physical state; precipitation and desiccation at a low temperature are essential. In the case of alumina, for instance, ignition must not be so intense as to destroy the solubility of the product in acid or alkali. Thoria has the advantage over alumina that it is less liable to contamination and can be purified by ignition to redness without loss of activity.

Sabatier explains the above reaction in his usual way on the basis of the temporary formation of an unstable compound, in this case a “thorinate.” The production and subsequent decomposition of the “thorinate” may be represented as follows:—



The equations represent the course of the reaction above 300° C.; below 300° C., an ether may be produced, as will be seen later.

Furthermore, Sabatier has demonstrated that the small quantity of sand usually introduced into the vessel in which ethylene is being produced by the action of sulphuric acid upon alcohol to prevent bumping, also acts catalytically. Anhydrous aluminium sulphate proves to be a much more powerful catalyst, both for hydrocarbon and ether production. With the higher alcohols, the chief product is an olefinic hydrocarbon. Clay, used in the form of small balls, has been found by Bouveault to possess quite surprising activity.

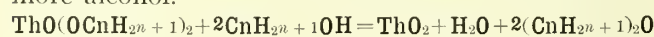
Though not a dehydration process, it is worthy of observation that olefines may also be obtained by passing the vapour of a paraffin monohalide over heated reduced nickel or copper, the resulting olefine and haloid acid being prevented from recombining by passage through potash. The chlorine derivatives decompose below 260° C., but the bromo and iodo compounds require higher temperatures. It is found, too, that barium chloride exerts a similar

catalytic effect at 300° C., and to a lesser extent the chlorides of lead, iron, cadmium and cobalt, all of which metals, it will be noticed, may function divalently. Chlorides of monovalent metals are inactive.

(b) *Production of Ethers.*—In Williamson's (1854) well-known explanation of the formation of ethyl ether from alcohol and sulphuric acid at 140° C., the rôle attributed to the acid is that of catalyst. Intermediate ethyl sulphuric acid is formed, and assumed to combine with further quantities of alcohol to produce ether and regenerate the sulphuric acid. Ether distils over uninterruptedly, if alcohol be allowed to flow continually into the mixture. The acid becomes gradually diluted with water and partially destroyed by side reactions, so that slight replenishment is necessary at intervals.

According to the later process of Kraft, ethyl ether and other members of the fatty series are prepared by the action of aromatic sulphonic acids, such as benzene sulphonic acid, upon fatty alcohols at temperatures exceeding 100° C. The reaction is explained in a similar manner to the preceding. Schröter replaces sulphuric acid by methionie acid, $\text{CH}_2(\text{SO}_3\text{H})_2$.

The production of fatty ethers by dehydration of the corresponding alcohols is only possible in a small number of cases, mainly the lower primary alcohols. Secondary alcohols are usually, and tertiary alcohols invariably, transformed into the ethylenic hydrocarbon. Alumina and thoria may then be substituted for sulphuric acid. Taking thoria as catalyst, the general reaction has for its second stage the interaction of the above-mentioned "thorinate," the product of the first stage, with more alcohol.



In an analogous way, it is possible to prepare the ethers of simple or mixed phenols. If phenol vapour, for instance, be passed over thoria at 390—420° C., diphenyl ether can be obtained to the extent of a 40% yield. This reaction is already practised on an industrial scale and has considerably reduced the price of diphenyl ether, which is employed in perfumery in large quantities as artificial essence of geranium. The phenol is liquified and made to fall dropwise into the end of a heated inclined porcelain tube containing the thoria. The resulting phenol and ether are separated by a single fractional distillation and the phenol unacted upon is then further transformed. The activity of the catalyst gradually diminishes, but can be restored by calcining in the air.

The three cresols passed over thoria are decomposed in the same way giving the three cresyl ethers, the para member of which also possesses the odour of essence of geranium.

If, in the preparation of diphenyl ether, the temperature be raised over 450° C., a second reaction is introduced in which diphenylene oxide results. This, by reason of its higher boiling-point, can readily be separated from the diphenyl ether.

Mixed ethers are obtainable by the use of an aromatic and a fatty alcohol. In this way, anisol and phenetol can conveniently be prepared. The

products obtained by passing the vapours of naphthol with either methyl or ethyl alcohol over thoria, comprise two perfumes which form the basis of cheap Eau de Cologne.

(c) *Preparation of Esters.*—Esters are usually prepared by the interaction of an acid and an alcohol, a process known as esterification. The reaction is analogous to the neutralisation of an acid by an alkali, but differs therefrom in being reversible and therefore incomplete, and in being far from instantaneous. On the latter count, acceleration of the process is generally resorted to by using a catalyst.

Esterification itself is an autocatalytic process, since the acid, though a diminishing quantity, can act to a certain extent as a catalyst. The process, in which an additional catalyst is employed, is differentiated therefrom by being classed as catalytic esterification.

The usual catalysts are the strong acids, hydrochloric or sulphuric acid, the latter being less efficient than the former though more generally worked with for the sake of convenience.

They are employed for the reaction when taking place in the liquid condition, but Sabatier has successfully employed some of the metallic oxides just mentioned as catalysts for esterification in the gaseous state. Thoria and alumina must be excluded, since they readily catalyse the decomposition of the acid itself, as will be seen presently. Titanium dioxide, being free from this objection, is most advantageous.

The reaction is best brought about by directing the vapours of equal quantities of the alcohol and acid (if volatile) into a column of this catalyst heated to about 300° C. With the same velocity and at the same temperature, but in the absence of the catalyst, it is safe to say that no interaction at all would take place. When benzoic acid is one of the reacting bodies, thoria may then be employed with success. Glucinum oxide, too, heated to 300° C. furnishes a good catalyst. Charcoal and finely-divided platinum are also stated to act as catalysts, though only feebly. A small quantity of water, on the other hand, exercises a retarding effect, probably by effecting some change in the catalyst.

In the case of acid catalytic esterification, the hydriions of the catalyst are supposed to be the active agents, since the activity of different acids is in the order of their relative strengths. The activity of the metallic oxide catalysts probably depends upon their double valency.

(d) *Production of Amines and Thiols.*—Still other compounds may be catalytically prepared from alcohols by means of metallic oxides. Ammonia and the vapour of a primary alcohol, when directed over thoria at 250—350° C., furnish a mixture of a primary and a secondary amine which is easy to separate. A mixture of ammonia and the vapour of a primary amine under the same conditions yields a secondary amine. Mixed amines, of course, may be prepared in a similar way. Secondary alcohols also produce amines, but not with such readiness as in the case of primary alcohols.

Primary and secondary alcohols, together with phenols, can also be made to combine with sulphuretted hydrogen to produce good yields of thiols, if a mixture of this gas and the alcohol vapour be passed over thoria at 300—350° C.

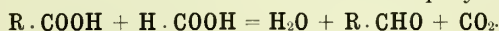
This general method for the preparation of amines and thiols—like those for ethylene hydrocarbons, ethers and esters above—can be explained on the assumption of an unstable intermediate body.

(e) *Production of Aldehydes and Ketones.*—It remains now to consider the dehydration of acids. Certain metallic oxides, differing from those above-mentioned, are found to catalyse the decomposition of acids into aldehydes or ketones.

Symmetrical ketones result if the acid be heated to 420—450° C. in the presence of thoria, titanium dioxide, zirconia, manganous oxide, ferric oxide, cadmium oxide or even chalk. By using a mixture of acids, say benzoic acid and a fatty acid, mixed ketones are produced. In every case, the acids may be replaced by their anhydrides.

Revivification of the catalysts just mentioned can also be effected by calcination in contact with the air. Precipitated chalk, though not so effective as thoria, retains its activity even after it has become coated with carbonaceous products, but its use is only satisfactory in the case of the lower members of the fatty series and of benzoic acid. The carbonates of barium, strontium, cerium and zinc are applicable only to the preparation of acetone.

To obtain aldehydes by this reaction, a mixture of the acid with formic acid must be employed:—



If titanium dioxide be employed at 290—300°, excellent yields are obtainable except in the case of benzoic acid. The reaction depends upon the decomposition of the formic acid with liberation of hydrogen, which then effects the reduction of the other acid.

HYDROLYSIS.

The reactions now to be considered comprise those in which the elements of water are added to a complex, followed by resolution of the product into simpler substances. The compounds capable of this treatment may be roughly classified as esters; amides, oximes and hydrazones; acyl derivatives; carbohydrates and glucosides; and lastly, polypeptides and proteins.

In the case of most of these substances, their hydrolysis is capable of catalytic acceleration. Indeed, the hydrolysis of esters may be regarded as one of the best known instances of catalysis, for the reaction, being comparatively slow, lends itself to the study of the phenomenon. We proceed now to a more detailed consideration of the most important of these reactions. Hydrolysis by enzymes is deferred until the next chapter.

(a) *Hydrolysis of Esters.*—The simplest process, viz., hydrolysis by means of water, is an autocatalytic action, since the acid liberated functions as a catalyst. The velocity of the reaction therefore increases with the time. Naturally, the reaction is

only possible in the case of the esters of comparatively strong acids. If, however, superheated steam be employed, the esters even of weak acids are affected. Thus, the hydrolysis of fats, which are natural glyceryl esters of certain fatty acids, by means of superheated steam is used as a commercial method for the production of stearic acid for candles.

Esters can also be hydrolysed by water in the presence of finely-divided metals as catalysts. At 50° C., e.g., platinum black accelerates the hydrolysis of ethyl butyrate. Far better results are obtainable by the method of Sabatier and Mailhe, in which a mixture of the ester vapour with excess of steam is passed over titanium dioxide at 280—300° C. The reaction is a reversible one; that is to say, if a mixture of fatty acid and alcohol vapour be subjected to but slightly divergent conditions, the corresponding esters are obtained, with yields rising to 70%. For acids of the benzoic acid type, thoria is of greater utility.

The usual catalysts employed, however, are acids and alkalis, both of which are used to an enormous extent in the hydrolysis—or as it is then termed, the saponification—of fats. With this branch of the subject it is proposed to deal separately at a later stage.

(To be continued.)

PERSONAL AND OTHER NOTES.

THE annual meeting of the American Chemical Society, which was to have been held in Montreal, Canada, this month, has been indefinitely postponed in view of the general warfare in Europe and the consequent political uneasiness felt throughout the civilised world.

The next meeting of the Biochemical Society will be on October 16th, 1914, in the Physiological Laboratory, University of London, S.W., at 5.30 p.m.

The Institute of Chemistry and the Society of Analysts have jointly appointed committees to consider what steps shall be taken to ensure a continued and satisfactory supply of (a) laboratory reagents, (b) glass and porcelain apparatus. The first committee consists of:—The Presidents and Hon. Treasurers of the Institute and the Society, with Prof. A. W. Cressley, Bernard Dyer, K. O. Forster, J. T. Hewitt, C. A. Hill, David Howard, H. A. D. Jowett, Sir William Tilden, Edmund White, and the Secretaries of the Institute and the Society. The second of the same officials with Prof. H. B. Baker, E. J. Bevan, Thomas Bolas, Bernard Dyer, Otto Hehner, J. W. Mellor, Sir Boverton Redwood, William Thomason, Sir William Tilden, E. W. Voelcker.

The Royal Mining Academy at Freiberg (Saxony) will celebrate its one hundred and fiftieth anniversary at the end of July, 1916. This institution is the oldest technical high school of its kind in Germany. The preparation of the festivities have been entrusted to a committee.

REVIEWS OF BOOKS.

"MODERN STEEL ANALYSIS." A Selection of Practical Methods for the Chemical Analysis of Steel, by J. A. Pickard. J. & A. CHURCHILL, London, 1914. Pages 128 + vi, with Appendices and Index. Chapters XXI., with 10 Illustrations. Price 3/6 net.

THE extraordinary development in the manufacture of steel within the last decade has called for a corresponding development in the rapid and satisfactory commercial analysis of those products, and in this work particulars are given of certain methods which have been selected for their practical value. The subject-matter is divided into some twenty-one sections, and is condensed into a small compass. There can be little doubt but that this volume will be of use to those who wish for information concerning the rapid estimation of the many elements found in modern steels.

"INDUSTRIAL ORGANIC ANALYSIS." for the Use of Technical and Analytical Chemists and Students. By Paul S. Arup. J. & A. CHURCHILL, London, 1913. Pages 340 + x, with Index. Chapters VIII., with 14 Illustrations. Price 7/6 net.

There can be little doubt but that this small work will find considerable use among the advanced students in our colleges, more especially those who are considering the more modern applications of chemistry to industry. The work is divided into eight chapters, which deal with such matters as the analysis of coal and coke, coal tar and distillation products, fatty oils and fats, soap, petroleum, and its distillation products, milk and butter, starch, and artificial colouring matters.

The arrangement of the subject-matter is such that the attention of the student is called to the practical side of his subject; and for this reason alone the volume has value. An interesting foreword by Professor J. C. Irving adds to its usefulness.

"A TEXT-BOOK OF ORGANIC CHEMISTRY." By A. F. Holleman. Edited by A. Jamieson Walker and Owen E. Mott. Fourth Edition. CHAPMAN & HALL, LTD., London, 1914. Pages 621 + xvi, with Index. Divided into 2 Parts, with 82 Illustrations. Price 10/6 net.

The success of this volume (in its English guise) in America has called for a fourth edition. It is interesting to note that the original Dutch work has passed through five editions and the German through ten. This work is so well known that it is unnecessary to more than point out that, in this last edition, additional space has been allotted to physico-chemical methods, and that the section on tautomerism has been entirely rewritten. The reader is advised by the author to confine his attention to the large type subject-matter on first reading, and only to deal with that contained in smaller type on a subsequent occasion.

"QUALITATIVE DETERMINATION OF ORGANIC COMPOUNDS," by J. W. Shepherd. W. B. CLIVE, London, 1913. Pages 348 + xvi, including Appendices and Index. Chapters XVII., with 21 Illustrations. Price 6/6.

This work is undoubtedly one of the best of those which deal with this branch of chemical analysis. It bears evidence of the great care taken in its compilation and it is almost impossible to praise it too highly. It is just what the worker wants, and the subject-matter included is so arranged that it is immediately available for reference purposes. The book is divided into two parts, the first containing twenty-two chapters and the second twenty-seven. No student in organic chemistry should be without this book, for it will be found invaluable in laboratory practice.

"CARBON DIOXIDE SNOW: ITS THERAPEUTIC USES," by J. Hall-Edwards. SIMPKIN, MARSHALL, HAMILTON, KENT & Co., LTD., London, 1913. Pages 78 + iv, with 21 Illustrations. Price 3/6.

This work chiefly appeals to medical readers, but in its description of the effects of freezing on the tissues, and in other directions it has an interest to the chemist.

BOOKS, ETC., RECEIVED.

"Essays and Addresses," by the late James Campbell Brown. J. & A. Churchill, London, 1914. Pages 208 + vii, with a Frontispiece and 22 Illustrations. Price 5/- net.

"The Practical Methods of Organic Chemistry," by Ludwig Gattermann. Translated by William B. Schober and Vahan S. Babasianian. Third American and Eleventh German Edition. The Macmillan Company, New York, U.S.A., 1914. Pages 401 + xi, with Index. Divided into 4 Parts, with numerous Illustrations. Price 7/6 net.

"Methods of Quantitative Organic Analysis." by P. C. R. Kingscott and R. S. G. Knight. Pages 284 + 16, with Diagrams. Longmans Green & Co. Price 6/6 net.

"Transactions of the Faraday Society, August, 1914." Pages 176, with many Tables and Illustrations. Price 10/6.

"Gases Found in Coal Mines," by George A. Burrell and Frank M. Seibert. Miners' Circular 14, Bureau of Mines, Washington, U.S.A., 1914. Pages 23.

"International Conference of Mine-Experiment Stations, Pittsburgh, Pa., U.S.A.," compiled by George S. Rice. Bulletin 82, Bureau of Mines, Washington, U.S.A., 1914. Pages 95, with 4 Illustrations.

"Physical and Chemical Properties of the Petroleum of California," by I. C. Allen, W. A. Jacobs, A. S. Crossfield, and R. R. Matthews. Technical Paper 74, Bureau of Mines, Washington, U.S.A., 1914. Pages 38, with 1 Illustration.

"Quarry Accidents in the United States during the Calendar Year, 1912," compiled by A. H. Fay. Technical Paper 73, Bureau of Mines, Washington, U.S.A., 1914. Pages 45.

"Monthly Statement of Coal-Mine Fatalities in the United States, March, 1914." Bureau of Mines, Washington, 1914. Pages 12.

"Fires in Lake Superior Iron Mines," by Edwin Higgins. Technical Paper 59, Bureau of Mines, Washington, U.S.A., 1913. Pages 34, with 2 Plates.

ENGINEERING NOTES.

By R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

Piecowork.

Notices have appeared from time to time in the *American Machinist* and other papers on the rapidity with which the Ford car can be turned out—working day and night, about 800 a day, or on an average over 24 hours, one car every 109 seconds, not every 40, as stated in most of the articles.

Nevertheless this is a remarkable achievement, and could only be accomplished by the use of special machines, kept up to time and rated as to their output, and special and very carefully supervised piecwork prices to the machine hands and erectors.

Interesting points not mentioned are the inspection charges and the percentage of waste castings, etc. Anybody at all familiar with the Royal Ordnance Factories at Woolwich, or the works of Messrs. Vickers or Messrs. Armstrong, will know that there is nothing new in all this, and that the only real pull the Ford people have is that they manufacture only one article from specially designed machines, whereas the large English shops mentioned have, by the nature of their output, to constantly change and adapt their tools and machines.

This country, however, possesses a vast number of fairly successful concerns where no system of piecwork obtains, and where the objection to such an arrangement is often raised that piecwork is inapplicable to their work or impossible to enforce to their men.

This objection can arise from several causes: the firm may manufacture only large articles of, by their nature, a somewhat solitary description; or may be chiefly concerned with repairs of a similar nature; or, in the case of chemical factories, may find the rating of their plant difficult owing to lack of uniformity in heat transmission (in evaporative processes), either on account of fuel variations or plant conductivity variations due to scale, etc.

In the first case mentioned, piecwork prices can really quite well be set if the machinery used is properly studied and suitable men are chosen to fix machine and men rates; and the same applies to the second class, though in that case larger margins must be allowed to cover insufficient information and facility afforded by the firms for whom repairs are being executed. In the third case, the difficulty generally arises from the causes mentioned under that heading, and this is largely due to the fact that the chemical industries in this country are in most instances much younger than the engineering ones, and, as the nature of their products is worse understood by the general public, their managements are tempted to try and snatch profits by the conversion of unsuitable plant to meet sudden modifications in demand; this applies with peculiar force to certain sections of the distilling industries.

One of the greatest stumbling blocks to progress in the application of piecwork, however, has not been mentioned,

and that is, the, in some cases unconquerable, aversion of a great many employers, especially if they be men of greater commercial than technical calibre, to stating a clear and honest system to their workpeople in writing or print of what they will pay per piece, or per day, of a given number of "pieces." Usually this arises from simple "funk" of being betrayed into a rigid agreement to pay a much higher price than is afterwards found commercial, or even necessary, from the point of view of the men's demands. If, however, they are honest to themselves and their workmen by the quick depreciation (financially) of their plant and the appointment of capable rate fixers, the cure, though apparently somewhat expensive at first, will be fairly rapid, and the benefits, when perceived, will be considerable. The sort of timidity mentioned is probably the cause of the small number of industries of the "Ford car" type in this country.

Explosion Engine Fuels.

In volume 63 of *Le Génie Civil* last year the above subject is discussed by A. Grebel, especially with reference to ordinary motor cars. As he then pointed out, the continual rise in the price of petrol makes the search for an effective substitute keener than ever, and the present appalling state of affairs is not likely to cheapen explosion engine fuel for a considerable time to come, any more than it will cheapen anything else. His views apply chiefly to France, for, to take only one example, he does not think enough benzol is produced to make it at all a serious competitor with petrol. In this country, however, a good deal of benzol is to be met with and does very good service. For heavy vehicles M. Grebel thinks there are considerable possibilities before highly-compressed coal gas, which will give a much larger radius of action weight for weight than anything in the nature of an electric accumulator, and which also is obtainable very easily in most parts of any civilised country, especially in the continent of Europe. There are one or two possible drawbacks to this in many ways likely scheme. To be really adaptable a small compressing set should be fitted on the vehicle to enable it to avail itself of any handy supply, but the cylinders under these conditions would have to be carefully cleaned periodically, as also all passages to the engine, in order to rid them of naphthalene and other constituents liable to be deposited from an ordinary town gas supply. For lighter cars the author suggests burning oil, chiefly on the ground that in a gallon of crude oil more burning oil is contained than petrol, while the calorific value of burning oil is higher, volume for volume, than that of petrol. The author suggests this would favour the consumer, as this class of liquid is sold by the gallon and not by weight; the certainty of this advantage seems very doubtful.

The use of burning oil, of course, besets the engine designer with several difficulties, for the compression before explosion has got to be lower than with petrol, and a radical alteration in the engine or carburettor, or both, would be desirable for this class of fuel. He touches, in passing, on producer gas for the heaviest commercial cars, but does not seem very sanguine about it—the writer remembers a car thus driven in the neighbourhood of Glasgow, and, it was alleged, at low cost—but the method shows no signs of having caught on in this country. At the time M. Greber wrote the cost of fuel in the total upkeep costs of a car, including tyres, wear and tear, and interest and depreciation, was about 10%. This is an interesting point to bear in mind, for it means that a reduction of 10% in fuel charges will only afford a reduction of about 1% on the total running costs.

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, *Chartered Patent Agent,*
Queen Anne's Chambers, Westminster, S.W.

10879/13. T. GOLDSCHMIDT AKT.-GES. **Alumino-thermic Mixtures.**

The oxides of cobalt, nickel, molybdenum, tungsten, or vanadium are used instead of chromic oxide in an alumino-thermic mixture as described in Specification No. 18671/12 for the production of carbon-free ferro-chromium from chrome iron ore. Alloys such as ferro-chromium containing cobalt with or without tungsten are obtained in this manner.

10996/13. L. VAN ALPHEN. **Manures.**

A manure consists of a solution of the substances that are abstracted from the soil by the plants for which the manure is used, but contains sulphate of iron instead of lime. The solution is absorbed in pulverized soft peat or peat-dust, and the material is dried in such a manner as to retain the pulverized state. In an example given, a solution of ammonium sulphate, anhydrous phosphoric acid, potassium oxide, and sulphate of iron is used.

11104/13. F. STEMMIG. **Viscose.**

Filaments or films are prepared by squirting viscose into a setting-bath composed of a solution of a neutral salt, to which a small percentage of an ammonium salt, such as ammonium sulphate, has been added to neutralise the effect of the free alkali in the viscose. Suitable neutral salts are common salt, Glauber's salt, or magnesium or calcium chloride, and a 10 per cent. addition of ammonium sulphate gives excellent results. Organic substances, such as glycerine or other tertiary alcohol, or oxidizing or reducing agents, such as are used in the case of acid baths or metal salts, may be added to the bath.

11124/13. E. W. KUHN. **Fermenting Beverages.**

In fermenting beverages under pressure as described in Specification 4622/08, the hydraulic pressure may be replaced, wholly or partly, by a pressure of carbon dioxide, air, oxygen, nitrogen, etc., applied to the surface of the liquid before and during the fermentation. A gaseous pressure of six atmospheres is stated to be sufficient.

11138/13. C. BILLINGTON. **Alloys.**

Antifriction alloys consist of a base of tin, together with antimony and copper, and 0.1 to 5 per cent. of nickel. The alloys may also contain lead. Specific examples of the alloys contain (1) 84 per cent. of tin, 9 per cent. of antimony, 6 per cent. of copper, and 1 per cent. of nickel; and (2) 74 per cent. of tin, 9.75 per cent. of antimony, 10 per cent. of lead, 5 per cent. of copper, and 1.25 per cent. of nickel.

11167/13. J. DE COSMO and H. QUINAUX. **Motor Spirit.**

Motor spirit is prepared by dissolving a substantial proportion of naphthalene in refined mineral oil, by means of a little nitro-naphthalene or naphthylamine, or both, and cresol, or of suitable homologues or derivatives. The oil preferred is of 0.760 or less specific gravity.

11175/13. A. PIDOUX and P. DE CARSLADE. **Cementing India-rubber.**

Vulcanized caoutchouc is cemented by painting with terpene hydrocarbons, such as pinene or terebenthene, or with volatile hydrocarbons, such as xylene, toluene, or benzene, the parts to be cemented, and by compressing,

under heat if necessary, until the hydrocarbon is evaporated. When repairing punctures or joining the ends of tyre-tubes the parts may be bevelled. A jet of steam, hot air, or oxygen may be applied during the compression.

11228/13. M. ROSSI. **Composition Fuel.**

Coal, alone or with the addition of other combustible materials and optionally a binding-agent, such as tar or pitch, is mixed with carbon bisulphide, preferably in a gaseous, vaporous or atomised state, and then briquetted. A generator of carbon bisulphide may have one or more exit tubes connected to a mixing and kneading receptacle for the materials, the materials being preferably moistened to facilitate the diffusion of the bisulphide and heated or not. Cannel coal may be briquetted without adding any binder, and 1,000 parts by weight of other coal may be mixed with 40 parts of pitch and 1 part of bisulphide.

9623/13. BADISCHE ANILIN UND SODA FABRIK. **Nitrogen Oxides.**

In the manufacture of nitrogen oxides by oxidising ammonia in the presence of a catalytic agent, the gases are purified and are prevented from acquiring dust-like impurities in their passage to the catalytic agent. The carrying of dust-like impurities is prevented by keeping the gases from coming into contact with iron or copper or other material of the apparatus which yields dust-like impurities to the gases. For this purpose, the gases after they have been purified are allowed to come in contact with apparatus formed of nickel or nickel alloys.

9281/13. L. LAFFITTEAU. **Sterilising Liquids and Purifying Air.**

Apparatus for sterilising liquids and purifying air by the combined action of ultra-violet rays and ozone, comprises an ozone generator surrounded by casings of quartz and glass respectively. Liquid flows through the annular space between the casings and passes to a suction conduit and is there atomised and mixed with the current of ozonised air induced through the ozone generator. The ozoniser consists of a group of electrodes moulded between conducting plates. For the purification of air, the suction device is removed and replaced by a fan.

9342/13. NORSK HYDRO-ELEKTRISK KOALSTOF-AKTIESELSKAB. **Manures.**

A fertiliser is obtained by evaporating to dryness without previous filtration a calcium-nitrate solution containing di-calcium phosphate in suspension. The solution may be obtained by dissolving a natural phosphate in nitric acid and precipitating with lime. The evaporation is carried out in vacuum apparatus at a temperature below 70° C.

9792/13. G. LIZEIRI. **Plastic Compositions.**

A composition for covering floors, walls and roofs, and for lining reservoirs, cisterns, baths, etc., consists of one part of Florentine magnesite cement (made by calcining and grinding a volcanic rock found in Tuscany), and three parts of a mixture in about equal proportions of sawdust, ground cork, asbestos and pumice, and if desired, ground paper, the whole being mixed with a solution of soft soap.

9867/13. W. GUNTHER. **Purifying Liquids.**

A reagent for softening water is obtained by evaporating sulphate lyes to dryness at a low temperature and fixing the free alkali by carbon dioxide by exposure to the atmosphere or to gases rich in carbon dioxide. Alternatively, the lyes may be treated with carbon dioxide before evaporation.

9960/13. FARBWERKE VORM. MEISTER, LUCIUS and BRÜNING. **Carbazole Sulphonic Acid.**

Carbazole and N-alkyl- or N-aryl- carbazole mono-sulphonic acids are obtained by sulphonating the bases by means of sulphonic or chloresulphonic acid in presence of an indifferent solvent or diluent; in an example, N-methyl-carbazole is treated with chloresulphonic acid in nitrobenzene.

9985/13. BRITISH THOMSON-HOUSTON CO., LTD. **India-rubber Substitutes.**

A rubber-like material is made by the vulcanization of a synthetic mixed ester of a polyhydric alcohol containing an unsaturated acid radicle, in which the multiple linkage occurs in an aliphatic group, as in oleic and cinnamic acids. The mixed ester may be mixed with castor oil or pitch before treatment with sulphur, and the vulcanized product may be mixed with a filler, such as talc, zinc oxide, silica, ground rubber.

10040/13. NEW OIL REFINING PROCESS, LTD., and E. L. LOMAX. **Hydrocarbon Oils.**

The gaseous products derived by cracking hydro-

carbon oils, particularly as described in Specifications 13675/08 and 28460/11, are polymerized by passing them through sulphuric, phosphoric, telluric or selenic acid. The resulting supernatant mixture of liquid paraffins and unsaturated siccative oils is drawn off and is separated by distillation in the presence of alkali which retains the siccative oils. The unsaturated siccative oils remaining in the acid are recovered by diluting the acid with water.

10055/13. G. E. HEYL and T. T. BAKER. **Ink.**

Sodium amyl sulphate in the proportion of about one-quarter per cent. is added to printing ink as a quick drying agent. Any of the isomeric sodium amyl sulphates may be used.

10204/13. VEREINIGTE CHININFABRIKEN ZIMMER & CO. **Hydrogenation.**

Organic substances are hydrogenated by treating with formic acid in the presence of a finely divided metal of the platinum group or a colloidal solution of such metal. In an example, hydroquinine sulphate is prepared by treating quinine bisulphate with formic acid in the presence of palladium black.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

Wrapping Material for Chemicals.

A new process for the manufacture of flexible and waterproof material, composed of a number of superimposed paper sheets, has recently been patented by Mr. Giovanni Magnasco, of Genoa, Italy. This invention is said to be of special interest to the chemical industry as it provides a very useful packing material for chemicals. Paper sheets are separately coated with a glueing solution comprising a mixture of animal glue, glycerine, albumin, camphor, linseed oil and sulphur, and these are afterwards "tanned" by means of formaldehyde solution, tannic acid, or the like. The paper used for this process is first coated or impregnated with the glueing mixture, afterwards one side of the sheets is coated with the tanning mixture (composed of formaldehyde and water or chromic acid, etc.), and the necessary number of sheets superposed in order to obtain the desired thickness. Lastly, the whole is compressed. According to the use to which it might be subjected, the material is again immersed in a tanning medium and then allowed to dry. Lastly, before it is put into use, it is coated with paraffin or other fats. Additional strength is added by placing between the sheets so treated tissues, woven threads, or metal wires, running parallel to or intersecting each other.

Growth in the Application of Polarimetry.

In recent years there has been a rapid extension in the employment of the polariscope for commercial purposes, and the United States Department of Commerce has found it necessary to reissue Circular No. 12, dealing with the basic principles of modern polarimetry. The preceding circular has been enlarged by a *résumé* of the work done at the Bureau of Standards and elsewhere. The publication deals further with the various scales (French, German and international), with light sources, various minor apparatus, the testing of raw sugars, the mixing of samples, the determination of moisture, the use of the refractometer, estimates of reducing substances, etc. The book is useful to practical

chemists, and can be obtained from the Director of the Bureau of Standards, Department of Commerce, Washington, D.C.

New Method of Improving and Preserving Yeast.

According to a recent issue of the *Allgemeine Brauer und Hopfenzeitung*, the fundamental action of oxygen upon yeast has been employed in various ways, e.g., by using ozone, ammonium persulphate, etc. But by the latter treatment the yeast was spoiled through the action of the increased acid reaction. According to a new method (patented by the Münchener Diamalt A.G.), persalts with a neutral or alkaline reaction are added to the yeast in small amounts (sodium percarbonate in quantities up to 1.5%), the yeast being kept in a covered vessel, thoroughly stirred for one hour. The disagreeable odour of the yeast disappears, it becomes tasteless and almost white; its growth is accelerated, decomposition inhibited and fermenting capacity increased, while it retains its original activity over long periods.

"Electro Potash," a New Fertiliser.

All attempts to utilise felspars, or other potassic rock constituents in Sweden, for the preparation of potassic fertilisers have failed, but a new method appears to offer possibilities. The process is due to Al. Lindblad and L. Yngström, and the raw material is a common rock in central Sweden called "leptite" or "eurite," similar in composition to a gneiss or felspar. It may contain up to 11% of potash. Leptite is mixed with coal and iron filings, and treated in an electric furnace provided with carbon electrodes at a temperature of 1,300° C. (approximately). The silicic acid in the rock is partially reduced to silicon, which then combines with iron to form an iron silicide, which collects in the bottom of the oven under a layer of slag consisting chiefly of potassium and aluminium silicate, which are more soluble than the silicates in the original leptite. The slag, when cold and finely ground, forms a grey powder and is sold under the name of electro-potash (electrokali).

The principal product, silicic iron, is easily disposed of as an alloy for various metallurgical uses, but in order that the manufacture should prove remunerative, a market must also be found for the electro-potash. The latter, on analysis at the Central State Experimental Station, shows about 11% of potash, of which 10% is soluble when the material is treated in the water bath with 20% hydrochloric acid, while shaking the material with 2% hydrochloric acid for 12 or 24 hours dissolved out 6 and 6.5% respectively.

The results of tests carried out with the new fertiliser were fairly satisfactory, and it is expected that further trials will yield still better results. If so, this new method of utilising native resources may prove an economic possibility.

Chemists in the German Army.

The Prussian Military Administration possesses two offices of construction, a testing laboratory and eighteen technical institutions. It has chemists employed in two pyrotechnic laboratories, two explosive factories, one cannon foundry, and a testing laboratory. Thirty-one chemists are engaged by the Military Administration, of which number eight are occupied in the testing laboratory. The entrance examination for these posts is very severe; it consists in work for the execution of which a period of three months is allowed to competitors, a written examination extending to three days, and an oral examination. All candidates must possess the title of doctor (Ph.D.) and hold superior diplomas. The competitors who succeed in passing these examinations are designated military chemists. They become military functionaries subject to the rules and customs of the military. The rank gives them (for example) the permission to marry. The pay commences at £100 per annum, reaching a maximum of £430.

Bay Rum and Florida Water in Canada.

A report on the bay rum and Florida water of commerce in Canada has recently been issued as a bulletin (No. 260) of the Inland Revenue Department by the chief chemist to the department.

Spiritus myrciæ of the United States Pharmacopœia was regarded as the official standard of bay rum, but Florida water had never received official recognition. The object of the inquiry was to determine whether wood alcohol has been used to a considerable extent in the preparation of these toilet articles instead of ethyl alcohol. In thirty-five samples of bay rum taken, six were made with, or contained, methyl alcohol, and of thirty-five samples of Florida water four samples were made from methyl alcohol. The latter is prepared so as to make it a perfectly suitable vehicle for many toilet articles, which, however, must be labelled as containing methyl alcohol.

Proposed Manufacture of Cyanide in the United States.

In a recent article which appeared in the *Mining and Engineering World* (New York) attention is called to the possibility of creating an important cyanide industry in the United States. The stoppage of foreign supplies of cyanide and cyanogen compounds has caused serious inconvenience to the consumers of cyanide which points to the urgency of obtaining home supplies.

The sources of the raw products are chiefly as follows: The blast furnaces, as fumes and flue dust, from which large amounts of potassium cyanide can be recovered. Cyanogen is produced not only in iron blast furnaces, but also in copper and lead furnaces, and in a general way in any metallurgical apparatus where nitrogen of the blast acts on incandescent

carbon mixed with alkali. In the purification of coal gas by hydrated iron oxide and its subsequent treatment, cyanide is obtained; this has been an old-time method of supply.

The extension of the by-product coke ovens, replacing the wasteful bee-hive ovens, constitute an abundant source of nitrogen products from which large quantities of cyanides should be obtained. The beet sugar industry is another source of cyanide, and has been utilised in Germany, this being a by-product obtained by the treatment of residual *vinasse*.

Formerly most of the potassium ferrocyanide from which other cyanogen compounds were made was obtained by fusion of dry refuse animal matter at a red heat, together with potassium carbonate and iron filings. Almost 3,000 tons of cyanides were yearly produced by this method. Cyanides can also be made electrically from atmospheric nitrogen products; by synthesis between carbon disulphide and ammonia; by heating ammonia charcoal and alkali; and from sulphocyanides. The abundance of materials available should enable America to create a national industry in order to make users independent of foreign supplies.

New Method of Obtaining Fertilisers from Brown Tennessee Rock.

One of the large Tennessee concerns has recently completed a plant which will treat Tennessee brown rock by a new process, details of which have not been made public. It is known that one feature involves the principle of gold ore preparation (that of wet stamping), which reduces about 80% of the phosphate rock to a degree of fineness which requires no further reduction for acid treatment. It is claimed for the new process that even rock carrying the minimum percentage of phosphate of lime will contain no more of the oxides of iron and alumina than the guarantee for several years has been on Tennessee rock of export grade; that the "available" will be largely increased in acid phosphate made by the new method, because of the decreased quantity of sulphuric acid required for treating the rock. If the new system works out on a commercial scale as well as it has experimentally, it will add to the resources of the country and be of advantage to the fertiliser industry.

French Artificial Wood.

Some attention has of late been directed in Lyons to an artificial wood which, it is stated, will be of value as a substitute for natural wood. The process consists in transforming straw into a solid material having the resistance of wood. The straw, after being cut into small pieces, is reduced by boiling to a paste to which certain substances are then added. When the paste has been reduced to a homogeneous mass it is put into presses, and planks, beams, laths, and mouldings of all sizes are produced. This new material can be sawn like natural wood. As a fuel it emits a bright flame and little smoke. It is further stated to be adaptable to the manufacture of match stems.

Graphite as a Lubricant.

Experiments by Prof. F. W. F. Goss have led to the conclusion that a combination of graphite and lard oil makes up a lubricating mixture which, when applied to ball bearings, will take the place of lard and oil, and at the same time gives a lower frictional resistance of the bearings and permits a large increase in the load carried. An oil or light kerosene, when mixed with graphite, becomes an effective lubricant when utilised under light or medium pressure.

M. L.

CONSULAR AND OFFICIAL REPORTS.

Chemical Trade of Leipzig.

H.M. Vice-Consul at Leipzig reports that the statistics for the first half of this year show that the growth of the exports of German chemical products has considerably increased as compared with last year. The value of the exports of chemical products during the first six months of this year was 490,670,000 marks, as compared with 482,880,000 marks during the corresponding period of 1913, and 394,040,000 marks in the first six months of 1912. The greatest increase was in pharmaceutical products, which rose from 50,270,000 marks to 57,250,000 marks, followed by a rise in the exports of dyes and dyeing stuffs from 150,920,000 marks to 153,420,000 marks, artificial manures from 25,800,000 marks to 27,500,000 marks, and ether and alcohol from 21,310,000 marks to 22,260,000 marks. The exports of chemical basic materials rose slightly from 197,120,000 marks to 198,190,000 marks. The Customs figures show a heavy decline during the half year in the value of the exports of explosives, munitions, and inflammable goods, viz., from 33,620,000 marks to 27,780,000 marks. Not much attention need be paid to this decline, however, as these goods in particular are largely exported under other descriptions.

The imports of chemical basic materials and products have increased by about 50% in quantity since 1907. In the first half of this year the imports of these goods amounted to 1,221,879 metric tons, valued at 271,980,000 marks, as compared with 1,154,500 metric tons, valued at 245,780,000 marks, in the corresponding period of 1913. The increase is almost entirely in chemical basic materials, acids, salts, and other basic chemical compounds. The value of the imports of pharmaceutical products increased from 19,340,000 marks in the first half of 1913 to 23,400,000 marks in the first half of this year. The value of the imports of artificial manures fell from 16,650,000 marks to 15,020,000 marks, and of explosives, munitions and inflammable goods from 840,000 marks to 620,000 marks.

Tanning Extract from Black Mangrove Bark.

Information regarding the production of a tanning extract from black mangrove bark has been received from Nassau, Bahama Islands. The statement regarding this extract is as follows: "In view of the fact that barks for the production of tanning extracts are becoming very scarce in some countries, attention is called to the recent experiments of an American industrial chemist, Dr. Charles S. Dolley, with black mangrove (*Avicennia nitida*). An apparently excellent tanning extract was obtained." Black mangrove is abundant in the Bahamas, especially on the largest island, Andros.

Phosphate Deposits near the Red Sea.

The development of the extensive deposits of phosphates near the Red Sea has, during the past two years, assumed important proportion, says a recent Consular Report. The mines, which are worked by the Egyptian Phosphate Co., a British concern, are connected by a twenty-mile railway with Port Safaga, on the Red Sea, where the rock is loaded on steamers for export. The rock is rich, containing 65% or more of tricalcic phosphate.

Chemical Manures in China.

The British Consul at Amoy reports that chemical manures, mostly sulphate of ammonia, were imported to the value of £23,728. These were largely used for poppy

cultivation, and it is thought that the suppression of opium will check importation in future, other crops, except perhaps sugar, not being sufficiently profitable to pay for their high cost.

Bean Oil Extraction by a Benzine Mill.

A Consular Report from Dairen (China) states that the new experimental bean-mill belonging to the South Manchuria Railway Co. started operations in the middle of April last. The mill is situated at Ji-ji-ko, about two miles from the Dairen wharves, and cost about £30,000, of which the plant cost about £20,000. The manager of the mill received part of his training in Germany, which may help to account for the fact that, with the exception of two boilers of British manufacture, the whole of the plant consists of the most modern type of German extracting machinery.

There are about fifty bean mills at Dairen, but this is the only one which extracts the oil by the benzine method. The South Manchuria Railway Co. is trying the experiment in order to prove whether the more modern method could be profitably employed in Manchuria. The mill is equipped for the manufacture of crude oil and bean meal from soya beans, and for the refining of the crude oil obtained. The maximum capacity of the mill is 80 tons of beans per day of 24 hours. At present only 50 tons are used daily, producing 7 tons of oil, 40 tons of meal, and 3 tons of moisture, dirt, etc. The crude oil is not at present refined at the mill, as no operatives are sufficiently trained to work the refining plant. Owing to the comparatively little moisture and oil in the residue obtained by this process, it will be possible to export this residue to Europe for use as a cattle food, and trial shipments for this purpose are to be made later on. At present the residue is sold in Japan as a fertiliser.

MARKET REPORTS.

LONDON.—The condition of the chemical markets remains quite abnormal, although the general demoralisation following the outbreak of hostilities has subsided. The complete stoppage of supplies of German chemicals and raw materials for certain manufactured articles caused importers as well as consumers an unpleasant surprise, and the rush for the small quantities available made heavy advances in values unavoidable. Stocks of some chemicals are now almost entirely exhausted, forcing consumers to substitution, where this is possible, or to curtailment of consumption until home supplies are forthcoming. A favourable feature of the chemical markets is the fact that, owing to the scarcity of money and the difficulties in obtaining credit, speculation is reduced to a minimum, so that the general position may be called entirely sound, if not quite satisfactory.

An interesting result of the war and the consequent cessation of the importation of aniline dyes from the Continent is a strong demand for vegetable dyes. The result of a noticeable fillip in the call for natural indigo has been a considerable rise of the price of the article. It would appear that this advance places synthetic indigo in a better position than ever, and British firms will no doubt devote their attention to this subject. The German patent rights having expired by the act of war, there seems to be a fair chance to make the manufacture of *synthetic indigo* a British industry, a plan which would be considerably helped by the abolition of the duty on industrial alcohol.

Nitrate of soda is quiet but steady. In view of the reduced consumption in this country and abroad it is doubt-

ful whether the present prices will be maintained. Ordinary nitrate is nominally quoted at 11s., and refined at 11s. 3d. Uncertainty characterises the market for sulphate of ammonia. Although the home production of this commodity is reduced, and stocks are not abnormally high, the limited shipments abroad, coupled with slow demand from British consumers, prevent an improvement of values, which remain at about £10 10s. per ton. Tar products have not improved as far as actual business is concerned, but a more confident feeling is noticeable. The partial stoppage of the export trade in several tar products places many makers in a very difficult position. Pitch is very quiet and prices are quite nominal, but the approach of the cold season promises a renewal of exports. Business in benzol is almost at a standstill, and stocks are accumulating. The hoped-for removal of the prohibition against shipping benzol to France would be a great help to the manufacturers. The nominal quotation for 90% benzol is 1s. 1d. per gallon. Toluol is scarce and firm at 1s. 2d. per gallon. Business in creosote is difficult on account of the scarcity of convenient tonnage, but values remain firm. Carbolic acid enjoyed a strong demand at firm prices. For crude 60% acid 2s. to 2s. 3d. per gallon has been paid, while crystals for prompt delivery realised 8d. to 8½d. per lb. Naphthas are neglected and prices favour buyers. Solvent is largely offered at 1s. 1d. per gallon.

MANCHESTER.—There have been some further advances in the values of heavy chemicals, particularly in those which are directly influenced by the war. Yellow prussiate of potash is only obtainable at fancy prices, *e.g.*, 1s. 7d. to 1s. 8d. per lb. Permanganate of potash has gone up to 155s. per cwt., and is scantily offered even at this rate. White powdered arsenic is firmly held at £19 to £20 per ton. The strong demand for lead salts keeps prices up. White acetate of lead has moved up to £35, and brown commands £32 10s. per ton.

LIVERPOOL.—The production of heavy chemicals in this district has been greatly stimulated by the cutting off of foreign supplies. Tartaric acid and citric acid are in good demand, but the small quantities available make the business difficult. Tartaric acid is quoted at 2s. per lb., and citric at 4s. Cream of tartar (98%) commands up to £11 per cwt. Sulphate of copper has received less attention on the part of consumers, but the quotation is maintained at £21 10s. per ton, in casks, f.o.b. Liverpool.

GLASGOW.—Business in the chemical markets is hampered by shortness of supplies and tightness of money. Values are still tending upward. Bichromate of potash has advanced to 7d. per lb. Some articles are entirely out of the market, and prices are not quoted.

Metal Markets.

LONDON.—The metal exchange being officially closed, there is little of interest to report on the copper trade. Private business is necessarily confined within narrow limits, though there has been a better tone noticeable during the last few days, and the tendency has somewhat improved. Copper warrants were well inquired for, but refined remained very quiet, electrolytic copper being readily offered at £55 to £55 10s. per ton. Home manufacturers of copper sheets and specialities owe most of their activity to Government orders, though the private demand is fairly satisfactory. Tin has developed a firmer tone on account of reduced offering and active covering purchases. No business is reported from the East, though Straits metal is now held at £136 10s., while English ingots are quoted at from £136

to £136 10s. per ton. There is a good demand for lead, and the current quotation for soft foreign metal near delivery is firmly maintained at £19 7s. 6d. English lead is obtainable at £19 15s. to £20. The lead works in South Wales are kept going continually. The zinc market presents a puzzling problem. In this connection a circular to the shareholders of the Zinc Corporation is of special interest. It appears that the contract for the sale of zinc concentrates to the smelters in Germany is void owing to the war, the market is disorganised, and the Broken Hill Proprietary Co., to which the concentrates are sold, are not operating their smelters. Hitherto the largest part of the production of spelter for European consumption has come from Germany and Belgium. The Germans have probably demolished the Belgian smelters, and even after the war it will take some time to bring the smelters into working order. The conclusion reached is that the company should remove the business from Germany to England.

FOREIGN ITEMS.

The Société Technique et Chimique de Sucrerie, of Belgium, announces that it is offering prizes of 1,000 and 500 francs for the best papers on the following subjects: (1) Which is the best method of evaporation or reheating, viz., that requiring the minimum of vapour, taking into account the loss of heat by radiation and by the condensed water? (2) Which sugar extracted directly from the beet (raw, crystallised or other) should be made in the factory to obtain the maximum profit?

The firm of Méro et Boyveau (A. Sittler and H. Bénard) in addition to their activity in conducting distillation of lavender oil in their own stills in the centre of the High Alps, are extending their activities to the cultivation of peppermint, the distillation of the oil, and the preparation of the terpeneless and "sesqui-terpeneless" oil.

The cartell of artificial indigo manufacturers, the headquarters of which are at Frankfort-on-Main, has recently effected a reduction of prices in order to meet the competition of the Baseler Chemische Fabriken and other makers of artificial indigo. The combination consists of the two well-known concerns of Höchstler Farbwerke and Badische Anilin und Soda Fabrik.

Japan.—The firm of Mitsui & Co. are said to contemplate the erection this year of a wood pulp mill at Obomari, in the Japanese portion of the island of Saghalien. It is estimated that the daily production will exceed 30 tons, this being the first mill of its kind in Japan. The annual production would represent about one-fifth of the Japanese importation of wood pulp.

FINANCIAL NOTES.

Lugan (Erzgeb).—The firm of Chemische Fabrik Lugan A.G. has been incorporated with a capital of 450,000 marks. The objects are the manufacture of chemicals. The company will acquire certain patents and apparatus from Siemens und Halske A.G. in Berlin for the manufacture of certain chemical products.

Hanau.—At the general meeting of the Hanauer Kunstseidefabrik A.G. (manufacturers of artificial silk), the president announced that more than half of the working capital had been lost by the concern. The total loss amounts to 1,335,027 marks. The works of the company have been closed since August last (1913) as it was impossible to raise the necessary capital.

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
 " " Abroad 8s. " "

The effect of cramming the ancient languages

is seen at its best (or worst) in the case of the so-called clever boy, who at the age of twenty-one is

"stale and tired with the reception of ancient learning, of other men's thoughts. . . . All he can make of his freedom is to go on absorbing ancient learning, keeping one's nose to the classic grindstone as if he were still a schoolboy. . . . One of the curses of intellectual England is due to schoolmasters keeping men at school and treating them as boys at the age of twenty. They take scholarships as stall-fed cattle take prizes at agricultural shows."

He draws attention to a fact, also previously noted in these columns, that either by accident or otherwise, some of our greatest men have escaped the undue influence of the schoolmaster. Too much attention must not, however, be paid to this factor, but it is worthy of passing comment, even if it is an example of special pleading.

Commenting on the long period of training on the classical side of our schools "from the age of eleven to twenty, which copies the German system," the remark is made that "the result is the same in both countries, where genius is very strong, but 99 per cent. of it is destroyed by the schools." We do not think that genius can be snuffed out in this manner, although it may undoubtedly be misdirected by being supplied with indifferent tools.

The point which Professor Perry brings out is certainly one which should be fully discussed, as no doubt it will be, that a boy should always leave school at sixteen, either entering the university or commercial life. It is worthy of note that Professor Perry was, on his own confession, at one time engaged in teaching the young, and no doubt this experience gives his remarks additional force. He frankly believes that it is only through the undying and ingrained belief of the English that knowledge and wisdom come from doing and not from abstract reasoning, that the schoolboy is saved from a lack of all initiative, as a result of his public school training. Hard hitting this; as if Huxley were once more amongst us.

Universities and their Influence.

The attack is most energetic when he is referring to the universities, and here it must be assumed that he has more especially in mind the older institutions. Even then it seems doubtful whether he has quite realised the gradual changes which are taking place in these institutions, which must leaven the whole mass.

"I get too angry," says he, "when I think of what our universities might do in the great world of natural science, and of the futility of almost all their studies. And this anger is the greater, when I think that the universities rule the schools. . . . If there is any particularly useless, poor, genteel clerk, you will find that his son must be taught Latin. . . . If there is any little township in a new country where everyone is ignorant, the schoolmaster must teach Latin."

The reason of this state of affairs is said to be, that the parents are hypnotised by talk about *good form*, and the schoolmaster on his part believes that the parents are opposed to reform. That "unbelief in the value of education is so general among the higher classes, that no reform can be expected unless some national disaster causes con-

version." Another factor which is fully recognised, but which Professor Perry does not allude to, is the vested interests of those who can only teach the dead languages.

May it not also be said, that part of this apathy on the part of the parent is due to his own past knowledge of this same school life, as judged by subsequent experience in the things of life as they are. Is it not possible that because of this he, too, has little real confidence in the school training? If so, the entire flank of the scholastic system is turned, and already subject to the silent condemnation of those who have received the so-called benefits of its system.

Professor Perry wields his searchlight with all the aptitude which would be expected from a practical engineer. He turns its rays on to a number of dark places. His searching criticism shows deep signs of his displeasure at the things he observes.

"Teaching of the young requires great wisdom, and we entrust it to people paid half wages, the 'otherwise unemployed.' A city is proud of its magnificent college of science, firstly, because of its architecture, secondly because of its apparatus, perhaps in steam- or gas- engines, and other expensive machinery, and the man in charge receives perhaps £200 a year. He ought to get at least £600. That is the market price of a fit man, and without a fit man the whole money, and the time of the students, is being wasted; the thing is really a fraud, a whitened sepulchre, and of course the principal is always a classical, non-scientific man. I know nearly all the technical and science colleges of Great Britain, and I scarcely ever see any of their complacent managers, members of their governing bodies, without wishing that I had some of the powers of the old Spanish Inquisition. What right have they to undertake duties which require a knowledge of natural science?"

The address is well worth the attention of all those interested in the future of education in this country, the more so "because after much thought and much experience I still think them (his proposals) to be correct, and I feel sure they must prevail." His closing remarks have a personal interest. "I must confess that it is only a very hopeful man who can peg away at a thankless task as Dr. Armstrong and I have been doing for so long." The answer to this remark, from the chemists' point of view, would be to point to the evidence of success as emphasised by that extraordinary banquet given to Professor Armstrong by his old students. What stronger evidence of appreciation could any man wish than this?

NOTES OF MEETINGS.

Chemical Society.

November 5th and 19th. Ordinary Meetings.

Society of Chemical Industry.

LONDON SECTION.—November 2nd.

Society of Public Analysts.

November 4th. The following Papers will be read:—
 "The Addition of Foreign Substances to Flour, with Special Reference to Persulphates," by A. R. Tankard.
 "Note on Bleached and Unbleached Flour," by R. T. Thomson.
 "Methyl Red as an Indicator," by R. T. Thomson.
 "Two Rapid Methods of Estimating Water in Crude Petroleum, Oil Fuel and Similar Substances," by H. S. Shrewsbury.
 "Note on Vinegar," by J. S. Jamieson, F.I.C.

NOTES ON RAPID METHODS IN STEEL WORKS LABORATORIES.

By C. T. NESBITT, A.R.S.M.

THERE are two main factors to be considered in obtaining results in a steel works laboratory, and they are accuracy and rapidity. How far the one may be subordinated to the other is a matter of circumstance and each case must be considered separately on its merits. Naturally, everyone in charge of such a laboratory endeavours to obtain the maximum in both directions; and it is the object of the writer to discuss some methods which have come under his personal observation in the course of many years' experience, and to point out the best (in his opinion) under certain specified conditions.

Some points to be considered are:—

(1) The main object of the laboratory, *i.e.*, whether the steel, iron, etc., is sold on analysis, or whether the analyses are merely a means of checking and regulating production.

(2) The class of assistance available, *i.e.*, whether technical men of good standing are to do the work, or whether it has to be done by men or youths who have started as bottle-washers, sample-crushers, etc., and have been "brought on" from that position.

These two factors are, to a certain extent, interdependent, and must be considered in relation to individual circumstances, such as cost, quantity and nature of output, etc., etc.

Take the case of a laboratory in connection with an open-hearth steel works, where steel is sold on analysis. This is the most rigid case of all, calling for the maximum of both accuracy and rapidity, and will, therefore, be the one mainly considered here.

With several open-hearth furnaces in operation, there will be a tap every few hours, and it will be necessary to get out analyses accurately in between the tapping time and the time the steel is rolled at the mill to a definite specification. This time will, of course, vary very largely according to the number of furnaces in use, the length of time the metal is in the furnace, the number of soaking pits or re-heating furnaces available, and other factors. Now it is almost impossible to get out a complete analysis that is accurate in under one and a half to two hours, and we will assume that the maximum accuracy and the maximum rapidity are practically equally important—one from a "works economy" point of view, the other from the selling or commercial side—and that the work must be got out in two hours or less.

The ordinary "complete analysis" of steel consists of estimations of carbon, sulphur, phosphorus, manganese and silicon, and it is necessary to complete these five in the time specified. Much of the efficiency of the laboratory will depend upon proper sampling arrangements. Immediately the sample is obtained at the casting pit, it should be sent to

the smithy to be forged and numbered, and from there to the laboratory. If the sample is mild steel, it may be judiciously cooled in water and drilled straight away. If hard steel (especially if anywhere about 0.8% C.), it must be allowed to cool slowly in the air, otherwise it will be almost impossible to drill it, or if capable of being drilled with a special drill, the drillings will be oxidised. A suitable drilling machine and good sharp twist drills are essential. It is false economy to use bull-nose drills or a cheap machine, both wear out quickly and cause delay through having to be sharpened or repaired frequently. The drillings, free from oxide or grease, are then ready for analysis.

During some seven years many tests were carried out on different methods of analysis both for rapidity and accuracy. The methods outlined as follows being those found most suitable, presupposing, as has already been said, that the analyses have to be done by young fellows who have only been trained to the work for a year or two. Of course, there must be efficient supervision, all standards being made up and check analyses done by a qualified man. With these proper precautions, rapidity and accuracy can be assured.

Carbon.—For mild steel Eschka's colour method with slight modifications is quite accurate, *provided the standards used are of the same make, and have had the same heat treatment as the assay*, and also provided that these standards are within 0.1% of the carbon of the assay (*i.e.*, a 0.2% carbon standard must only be used for steels ranging from 0.15 to 0.25% carbon).

Weigh out 0.7 gm. each of steel and standard and transfer to dry $\frac{5}{8}$ in. $\times$ 6 in. test tubes, add 13 c.c. of 1.2 sp. gr. nitric acid, boil for 15 minutes on a water-bath, cool gradually and compare. A 30 c.c. comparison tube is most convenient; the standard is diluted to a convenient multiple of its carbon contents, the assay compared with dilution till of the same tint by reflected light, and the total number of cubic centimetres divided by the multiple.

For hard steels this method is also satisfactory in the hands of a practised man, and under the conditions stated above, especially does the italicised condition apply here. Of course a smaller weight is taken for analysis, 0.3 or 0.2 gm., otherwise the colour developed is too dark for accurate comparison.

Time for analysis, 20 to 25 minutes.

Combustion Analyses.—Wet combustion methods take too long and are inadmissible. Direct combustion with MgO and oxygen, by weighing the CO₂ formed and absorbed in potash, is by far the simplest, and is as accurate as any other. The MgO must be very thoroughly calcined before use, and for some physical reason results are more accurate and con-

cordant if the MgO is smoothed over on the surface, level with the sides of the boat, with a polished spatula. Clay boats can be made in the laboratory with the help of a wooden mould and former out of any decent fireclay. These, when dried slowly and calcined, are strong enough and cost practically nothing. Landsiel's bulbs are one of the best form for potash. It is much better to use oxygen from some form of pressure bottle than direct from the cylinder. Two Winchesters connected with rubber and glass tubing and screw cocks, with water as the containing fluid, answer very well; by raising one bottle on a support the pressure can be adjusted to a nicety, and half a Winchester of gas is amply sufficient for one estimation. A combustion can be performed comfortably in 40 minutes. The method is used for special steels—binary, ternary, etc.—and for standardising purposes. It is also applicable to alloys, spiegeleisen, ferromanganese, ferrosilicon, etc. Where the melting-point of the alloy is very high the addition of a portion of an ordinary carbon steel will lower it and give satisfactory results—of course deducting the carbon so introduced.

Perhaps the mention of a French method by M. de Nouilly, of the St. Chamond Steel Works, will not be out of place here. Briefly, it is to burn the steel by means of an electric current (with or without addition of PbO_2) in an asbestos cup suspended in an airtight conical flask, and into which oxygen is forced under slight pressure. The flask has a known quantity of potash in it, and after the combustion the excess potash is titrated with $\frac{N}{10} \text{H}_2\text{SO}_4$, using phenolphthalein as indicator. It is said that carbon can be estimated in five to seven minutes. The writer has had no personal experience of this method, but thinks it deserves mention as essentially practical and rapid, but for general use it would probably have to be in charge of a qualified man.

Sulphur.—The estimation of sulphur in steel by the evolution method is by far the most rapid and is accurate under proper conditions. Ten grammes of the sample are dissolved in 100 c.c. chlorine-free HCl and 30 to 40 c.c. H_2O , in a flask fitted with a delivery tube and small trap or condenser, connected to a bulb U-tube containing dilute NaHO. The evolved gases bubble through the NaHO, which must not be allowed to get warm or decomposition of the sulphide may result. The steel is dissolved with gentle heat and when all is in solution the liquid is boiled for three to five minutes, which will drive out any remnants of SH_2 , and not appreciably affect the temperature of the NaHO. This caustic solution is poured into excess cold dilute H_2SO_4 , containing a known quantity of iodine, the iodine being in excess of the sulphide present. The excess iodine is then titrated with the hypo solution, using starch as an indicator. If the iodine solution is standardised against a steel of known sulphur contents, the results are quite accurate, or even if the iodine solution is made up theoretically so that 1 c.c. is equivalent to .001 gms., the results are accurate to .002 %.

Time required for analysis, 20 to 25 minutes.

An alternative method is to absorb the evolved gases in bromine water; destroy excess bromine with ammonia, make solution acid with HCl and add 5 % in excess; precipitate with BaCl_2 , filter, ignite and weigh as BaSO_4 . This method is supposed to be more accurate than absorption in NaHO, owing to the probable oxidation of organic sulphur compounds (such as mercaptan) by the bromine, and for the same reason the modification of passing the evolved gases through a red-hot tube before absorption is advocated by many chemists. The writer, however, is quite in agreement with T. G. Elliot (compare Iron and Steel Institute paper, May, 1911), who says that only a very slight trace of sulphur is evolved in organic combination, certainly not sufficient to affect results.

Standard steels are, of course, checked by both the above methods and by the oxidation process.

Phosphorus.—The ordinary molybdate process can be modified to obtain accurate results in 40 to 45 minutes. Three grammes of the steel are dissolved in 50 c.c. of HNO_3 (sp. gr. 1.2), heated to boiling, and 10 c.c. of a solution of potassium permanganate (25 gms. per litre) added for mild steel, 15 c.c. for hard steel, to ensure complete oxidation. The solution is cleared with 10 c.c. HCl and boiled down to a low bulk, not dryness. Fifty cubic centimetres of a saturated solution of ammonia nitrate are added, the assay is heated to incipient boiling and the phosphorus precipitated with 45 c.c. of molybdic acid solution. This analysis should be done in a large conical beaker so that the precipitate can be thoroughly agitated for a few minutes and then allowed to stand for ten. It is filtered through paper pulp (with or without a suction pump) and washed free from acid with cold distilled water. The pulp and precipitate are transferred back to the conical flask, a little water and a few drops of phenolphthalein added, then excess of $\frac{N}{10} \text{NaHO}$,

which is titrated back with $\frac{N}{10} \text{H}_2\text{SO}_4$ till colourless,

and finally a drop or two of the $\frac{N}{10} \text{NaHO}$ will bring back the pink colour of the phenolphthalein used as indicator. One cubic centimetre of $\frac{N}{10} \text{NaHO}$

theoretically equals .0033 % phosphorus on 3 gms. steel. In practice .003 is the correct figure to take. The molybdic acid solution is made up by taking 200 gms. of MoO_3 and mixing into a paste with water, 420 c.c. of .88 AmHO is stirred in and more water added till total water used is 420 c.c. This solution should be clear, if not filter and *pour the clear solution into 2,500 c.c. of HNO_3 of 1.2 sp. gr., with constant agitation.* These operations must be carried out carefully or much of the molybdic acid will be precipitated and the solution spoiled. Ten per cent. ammonium molybdate solution can be used, but does not give such a clean and crystalline yellow precipitate.

The above method has been repeatedly tested

against the standard method, and has been in use satisfactorily for many years. Even with small quantities of arsenic present it gives accurate results. A series of fifty duplicate analyses by this method and by the standard one, using zinc to eliminate arsenic and weighing the yellow precipitate, gave results which varied in the aggregate by only .001%, the largest difference being .004%. Many of the steels contained up to .15% arsenic, showing that As does not interfere with its estimation.

Manganese.—Of the many methods tried and used, the following can be done in 15 minutes, and is accurate when a little practice has been obtained in colour comparison. .1 gm. of assay and standard steel are weighed into tubes and 10 c.c. of 1.2 HNO_3 added. The tubes are then heated in water bath till all nitrous fumes are off. They are cooled and 2 c.c. of a solution of AgNO_3 (1.2 gm. p. l.) added and then about .3 gm. of ammonium persulphate. The tubes are returned to water bath and boiled for three minutes, again cooled in a beaker of water and, when cold, the pink silver permanganate formed is compared in the usual way.

A slight modification of this method makes for accuracy (by weighing a larger quantity of steel) and also saves one weighing. A standard manganese solution is made up by dissolving 2 gms. per litre of a steel known manganese contents, using, say, 100 c.c. 1.2 HNO_3 per litre for its solution. For the analysis .2 gm. of the steel to be analysed is weighed, dissolved in 10 c.c. HNO_3 (1.2 sp. gr.) and heated as before. This is then diluted to 100 c.c., and 10 c.c. pipetted off into a clean tube. Ten cubic centimetres of the standard manganese solution is pipetted into another tube, then 2 c.c. AgNO_3 solution and .5 gm. of ammonium persulphate added to both. The colour is developed by three minutes boiling and compared.

Another modification is a titration of the pink permanganate solution with standard arsenic till colourless. This necessitates more standard solutions and has no advantage, provided assistants have a fairly good eye for colour. Most youths or men can be quickly trained to perform colour-comparison analyses with a considerable degree of accuracy.

Silicon.—The sulphuric acid method is the most rapid and is quite accurate. Five grammes of steel are weighed into a beaker, 60 c.c. H_2O and 15 c.c. concentrated H_2SO_4 added, and heated till all is in solution. Oxidise with just sufficient concentrated HNO_3 and take to dryness. Add boiling water, boil and filter. Wash with water, HCl , and again with water till clean, ignite and weigh.

In the usual sulphuric acid method the steel is dissolved in nitric and sulphuric acids, and also 10 c.c. of HCl are added (after evaporation to fuming) with the boiling water. With regard to the nitro-sulphuric acid, silicon is soluble in this mixture, but is almost, if not quite, insoluble in dilute H_2SO_4 alone. Better results are obtained by using H_2SO_4 and oxidising when the steel is in solution. The addition of 10 c.c. HCl proved to be unnecessary on a series of 100 duplicate analyses, the results being identical with or without the addi-

tion, and it was dropped altogether because the SiO_2 was found to filter decidedly quicker without it. The saving of time, taken over several days continuous work, averaged over 10 minutes.

Time taken for analysis, 1½ hours.

It seems to be a generally accepted impression that the sulphuric acid method for the dehydration of silica fails occasionally. This is not the writer's experience with the above method. Even with steels containing very high silicon percentages it checks out well with the HCl evaporation method. It is a well-known fact that this standard HCl evaporation method requires two dehydrations and baking for *absolute* accuracy; the same is true of the sulphuric acid method, but the difference is so very small that the two evaporations are rarely carried out in practice, and certainly never in a busy steel works laboratory in the ordinary course of work. Wunder and Suliemann (*Ann. Chim. Analyt.*, 1914, 19, 45—49) say that 3.5% of the weight of silica remains in solution when evaporated with H_2SO_4 , but this loss is recovered on a second evaporation. 3.5% of the weight of silica on a steel containing .06% is an error of .0027%, on .1 would be .0045, comment is needless. The probable cause of failure in any of the sulphuric acid methods is incorrect adjustment of the acid; with the right quantity of H_2SO_4 the assay goes to a solid mass of ferric sulphate and can be baked for a time if considered necessary.

Using the above methods a complete analysis, including both sulphur and phosphorus estimations done in duplicate, can be finished in two hours with ease. The weighings are done together and all estimations started off together. The carbon and manganese are compared while the sulphurs, etc., are dissolving. By that time the phosphorus will be ready to precipitate; that done, the sulphurs are titrated and the phosphorus finished, the silicon being looked after at intervals. Thus everything but the last mentioned can be got out in about 1½ hours, and a smart man used to the work can do it in the hour.

Four complete analyses for one man is a good day's work (eight hour shift), five means very concentrated and rapid manipulation, and should only be expected occasionally under stress of circumstances.

The rapid methods for steel specified above can most of them be modified and used for pig iron analysis, etc. The sulphur evolution method is not accurate for high sulphur pigs, but here again, if the iodine is standardised against a pig iron of known contents, the results on the same class of pig will be sufficiently accurate for blast furnace and works purposes. With hematite pig the method may be said to be accurate, it is only when the sulphur contents approaches .1% that it begins to fail.

The phosphorus method is applicable, the only modification being a necessity to add more potassium permanganate to ensure complete oxidation, and to filter off the gelatinous silica (with a high silicon pig), when the assay has been taken to near dryness. Complete removal of silica is of course

not essential as the molybdate precipitate is not weighed.

The manganese estimation can be done with fair accuracy but takes time. The pig requires at least an hour's boiling in the water bath to ensure proper solution, and subsequent filtration.

The silica method is accurate for any class of pig and requires no modification, except that with high silicon pigs a smaller quantity of the sample should be taken.

The methods outlined above have stood the test of many years in actual practice. Taking the sulphur estimations as an example, in the course of about seven years eighty or more samples were checked by various independent analysts. Ninety-five per cent. of these independent results checked out with those in the laboratory to .002%, the remainder differed by no more than .004%, and could generally be accounted for by slight variations in the material under analysis.

One of the main points in securing accurate results in an iron and steel works laboratory, where many thousand estimations are put through in the course of a year, is to mechanise operations as much as possible. In this connection there is something to be said for Messrs. C. H. and N. O. Ridsdale's method of what may be termed "tabloid analysis" (see *Proc. Iron and Steel Institute*, May, 1911). Their well-known system of adding reagents in tabloid form and generally making analysis a mere sequence of operations, may be useful for semi-skilled assistants, but the writer is of opinion that equally good results can be obtained with solutions

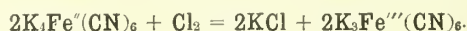
made up in the laboratory at less expense, and with far less fear of contamination. If the standard solutions and reagents are arranged in stock-bottles feeding "bottom-fed" burettes, the action of running so many cubic centimetres into a vessel is practically as simple an operation as putting in a tabloid, leaving out of account the fact that the tabloid must of necessity take an appreciable time to dissolve. This solution method is applicable in all cases (with the possible exception of ammonium persulphate), while the tabloid manipulation is very restricted. A comparison of times taken for analysis shows nothing in favour of Messrs. Ridsdale's scheme, and it would appear to be a useless procedure to have many reagents made up into tabloid form unless distinct saving in time or accuracy is indicated.

Many analytical chemists in charge of laboratories favour the "one man one estimation" procedure. That is, in steel analysis, one man does all the carbons, another all the sulphurs, and so on. This is only possible when the samples are available early in the working day, a condition which is only fulfilled in independent laboratories, as distinguished from those pertaining to works. Certainly, where possible, this procedure increases accuracy as the estimations become naturally more mechanical and the assistants more specialised in their respective estimations. There is no doubt that it destroys initiative and any necessity for thinking on the part of the assistants, which, with non-scientific assistants, would be an advantage, but with good men the reverse.

SUGGESTIONS FOR THE PREPARATION, ANALYSIS AND SEPARATION OF FERRICYANIDES.

BY HERBERT E. WILLIAMS, F.C.S.

THE soluble ferricyanides are produced from the ferrocyanides by oxidation, and the potassium salt is usually produced by the method first proposed by Leopold Gmelin, by passing chlorine through a solution of potassium ferrocyanide until the liquid yields no blue reaction when tested with a ferric salt; this reaction may be expressed thus:—



The solution, after evaporation on the water bath and cooling, deposits crystals of fairly pure potassium ferricyanide, which may be rendered quite pure by recrystallisation; the crystals obtained by evaporating the mother liquor are, however, contaminated with potassium chloride.

This method, though fairly satisfactory for the preparation of the potassium salt, is inapplicable for the preparation of the sodium, ammonium, or alkaline earth metal salts, chiefly on account of the greater solubility of the ferricyanides of these bases, and the great difficulty, and in many cases the im-

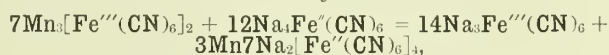
possibility, of separating them in a pure condition from the associated chloride.

A number of other processes have been proposed which are tedious or give rise to other salts from which it is difficult to separate the ferricyanide.

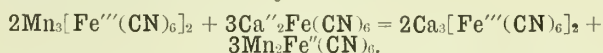
This difficulty may be easily overcome by the now suggested process, whereby any soluble ferrocyanide of the alkali, or alkaline earth metals, may be readily converted into a solution of the corresponding ferricyanide, entirely free from any other salts, and in a neutral condition; and by evaporating the solution *in vacuo* crystals of the pure salt may be obtained in fine ruby-coloured crystals with high yield, and free from discoloration due to the precipitates of blue or green iron cyanogen compounds.

To 100 gms. of sodium ferrocyanide dissolved in 1,000 c.c. of water add a solution of manganese chloride, or sulphate, until the ferrocyanide is completely precipitated; the mixture, which contains white manganese ferrocyanide of the formula $Mn_7Na_2 [Fe(CN)_6]_4$ in suspension, is raised to the

boil and nitric acid added until oxidation is complete; by this means the white manganous ferrocyanide is converted into the brown manganous ferricyanide; the mixture is then thrown on a vacuum filter and thoroughly washed; this is not a lengthy operation as the precipitate filters fairly well. The washed paste is then added to a solution of a ferrocyanide and agitated, when the following reaction takes place: with sodium ferrocyanide:—



and with calcium ferrocyanide—



The addition of the brown manganous ferricyanide must be continued until it ceases to turn white on agitation and some of the brown compound remains in excess; the liquor is then filtered off and the pure ferricyanide solution evaporated under reduced pressure; the washed precipitate of white manganous ferrocyanide may be mixed with more water and reoxidised with nitric acid and thus be used for the conversion of a fresh quantity of ferrocyanide.

This reaction takes place in the cold for all soluble salts except the ammonium salt: in this case the conversion only takes place on heating; this salt is, however, best prepared by precipitating a solution of the barium salt with sulphate of ammonia.

The following ferricyanides have been easily prepared by this method, the ammonium salt $(\text{NH}_4)_3\text{Fe}'''(\text{CN})_6$ in ruby-red anhydrous crystals quite permanent in the solid state; the solution decomposes on heating, but is more stable than the corresponding ferrocyanide.

The barium salt $\text{Ba}_3[\text{Fe}'''(\text{CN})_6]_2 \cdot 20\text{H}_2\text{O}$ crystallises in fine large ruby-red crystals, very soluble in water, the crystals effloresce in dry air and lose 8 molecules of water and a further 8 molecules are given off at 100°C .; from this salt the ammonium, potassium, sodium, magnesium, or lithium salt may be obtained by double decomposition with the corresponding sulphates; the calcium salt $\text{Ca}_3[\text{Fe}'''(\text{CN})_6]_2 \cdot 15\text{H}_2\text{O}$ crystallises in small brownish-red crystals which effloresce in dry air and lose 7 molecules of water at 100°C . The magnesium salt $\text{Mg}_3[\text{Fe}'''(\text{CN})_6]_2 \cdot 18\text{H}_2\text{O}$ is exceedingly soluble but separates when evaporated over sulphuric acid, in red crystalline masses which effloresce in the air.

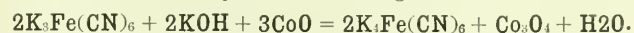
The lithium salt $\text{Li}_3\text{Fe}'''(\text{CN})_6 \cdot 7\text{H}_2\text{O}$ is a soluble salt and crystallises in reddish-brown needles which are very deliquescent in moist air, at 100°C . 5 molecules of water are lost with slight decomposition; the solution decomposes considerably on boiling under ordinary pressure. The sodium salt $\text{Na}_3\text{Fe}'''(\text{CN})_6 \cdot 2\text{H}_2\text{O}$ crystallises in small red-brown crystalline plates which are very soluble in water, and deliquesce in moist air, the crystals become anhydrous at 100°C . The strontium salt $\text{Sr}_3[\text{Fe}'''(\text{CN})_6]_2 \cdot 12\text{H}_2\text{O}$ reddish-brown crystals which lose 2 molecules of water in the dry air and a further 4 at 100°C .

The analysis of a ferricyanide in solution is usually accomplished by first reducing the ferricyanide to ferrocyanide and then estimating the latter body so formed by (a) N/10 permanganate solution; (b) titration with a standard solution of a copper or zinc salt; (c) or by titration of the cyanide obtained by distilling the ferrocyanide with dilute sulphuric acid and a little cuprous chloride and absorbing the evolved hydrocyanic acid in a caustic alkali solution (*J. S. C. I.*, p. 315, Vol. 31).

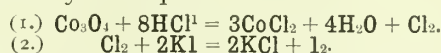
If the ferricyanide is free from other cyanogen compounds it may be estimated by the latter method without previous reduction if a larger amount of cuprous chloride is added.

If the ferricyanide exists in the presence of ferrocyanide but in the absence of other oxidisable salts, the ferricyanide may be estimated by first titrating the ferrocyanide with N/10 permanganate solution, and then reducing the total ferricyanide by warming it with ferrous hydroxide in presence of an excess of alkali; the acidified filtrate is again titrated with permanganate, the difference between these two ferrocyanide readings will correspond with the proportion of ferricyanide originally present.

Instead of the ferrous hydroxide mentioned above for the reduction of the ferricyanide, manganous, or cobaltous hydroxide, may be substituted with greater advantage, and, if only the ferricyanide is to be determined, it may be reduced to ferrocyanide in the cold by the addition of cobaltous hydroxide and excess of alkali with agitation, black cobalto cobaltic hydroxide being formed thus:—



The black hydroxide is filtered off, thoroughly washed and distilled with an excess of hydrochloric acid, and the evolved chlorine absorbed in potassium iodide solution, which is finally titrated with N/10 sodium thiosulphate solution. These reactions may be expressed:—



Each c.c. of sodium thiosulphate solution required is equivalent to 0.03292 gm. potassium ferricyanides.

If the ferricyanide exists in the presence of ferrocyanide and thiocyanate or other oxidisable salt, the two iron cyanogen compounds may be separated from the other salts and from each other by taking advantage of the different properties of their zinc salts.

The solution containing not more than 1 gm. of the mixed iron cyanogen compounds is acidified with dilute hydrochloric or sulphuric acid and the two compounds separated together by the addition of an excess of a soluble zinc salt, and the precipitate filtered and washed; the precipitate is then digested with an excess of sodium carbonate, when the whole of the ferricyanide of zinc is decomposed and sodium ferricyanide passes into solution, but the ferrocyanide of zinc will be unattacked, the mixture is then filtered and washed; the filtrate which contains the whole of the ferricyanide is estimated as cyanide by distilling with dilute sulphuric acid and

cuprous chloride into caustic soda solution; the precipitate on the paper of basic ferrocyanide and carbonate of zinc is then also put into the distilling flask together with the paper and dilute sulphuric acid, and cuprous chloride added and distilled in the manner described; 1 c.c. of N/10 silver nitrate used to titrate the cyanide obtained from the filtrate will equal 0.01097 gm. $K_3Fe(CN)_6$ and from the insoluble matter = 0.012277 gm. $K_4Fe(CN)_6$ or 0.0070633 $Fe(CN)_6$ gm.

Ammonia solution may be substituted for the sodium carbonate in the separation of the zinc salts, zinc ferricyanide being readily dissolved by ammonia while the ferrocyanide is insoluble, but this method

offers no advantage and the precipitate is difficult to filter.

Soluble ferrocyanides cannot be separated from ferricyanides by means of ferric chloride as is frequently stated, for, although a pure ferricyanide solution is not precipitated by ferric salts, yet in the presence of ferrocyanides considerable proportions are precipitated as a green ferric ferrocyanide.

Ferrocyanides may be separated from ferricyanides by shaking the solution, made alkaline with carbonate of sodium or potassium, with an excess of freshly precipitated zinc carbonate; the whole of the ferrocyanide is precipitated while the ferricyanide remains in solution.

CHEMICAL INDUSTRIES.

A Monthly Review of the Progress of Technical Chemistry.

METHODS FOR DETERMINING THE OXYGEN ABSORPTION OF DRYING OILS.

By ARMAND DE WAELE.

VARIOUS attempts have been made to correlate the iodine values of drying oils with the amount of oxygen absorbed, when thin films are exposed to the atmosphere. The earliest seems to be that of Livache, who spread drops of oil upon finely-divided lead, obtained by precipitation of the metal in lead acetate solution by means of zinc, and rapidly washing and drying the spongy mass. This procedure has been modified in several ways by subsequent experimenters. Bishop spread the oil upon finely-divided silica, using manganese resinate to accelerate the drying action. Hübl and Lippert proposed to use copper powder as a support for the linseed oil during drying.

None of these methods give any other data than the increase in weight due to oxidation; the figures obtained are the resultant of the increase in weight due to absorption, less any loss due to volatile products of decomposition. There is evidence that the latter may be considerable, when large quantities of linseed oil are oxidised at the ordinary temperature, as in the "oxidising sheds" in linoleum factories, the acrid volatile products of decomposition attacking the light iron gutters in the interior of the building, which are entirely dissolved in the course of a few months. Workmen entering the building during the course of oxidation also experience difficulty in breathing.

In the case of these increase in weight determinations, the maximum is recorded in a very short time, depending on the nature and amount of driers used, temperature of exposure, access of light, etc., followed immediately by a gradual decrease in weight, which, according to some authorities, may even lead to a final loss in weight on the original one.

A departure from the foregoing methods was that of Wilson and Heaven (*J. S. C. I.*, 1912, 31, 565), in which the authors determined the amount of oxygen absorbed by heating the oil spotted on dried kieselguhr in a large sealed flask containing a sufficiency of oxygen, afterwards breaking the seal under water and calculating the diminution in volume to grams of oxygen absorbed per 100 parts. From the figures given as to agreement in duplicate determina-

tions, this seems to be a convenient method for obtaining comparative values, but there appear to be various flaws in the subsequent reasoning dealing with the value of the method as an absolute one.

In the Wilson and Heaven method, the authors have eliminated the variations which necessarily occur in the older plate or film methods, by reason of the atmospheric influences on the oxygenated product, *i.e.*, there is little reason to doubt that a variable amount of moisture may influence the decomposition of the oxidised body. At the same time they have not taken into account the fact that the residual gas in the reaction flask will consist of the volatile products of decomposition in addition to the unabsorbed gases of the atmosphere. The figure returned as "oxygen absorbed" will be the resultant of absorbed oxygen, less the carbonic acid, etc., evolved and the vapour pressure due to the products of decomposition, such as formaldehyde, formic acid, etc.

Recently Krumbhaar (*Chem. Revue*, 1913, 20, 287) (in connection with a method devised to test the rapidity of oxidation of linseed oil), has used a modification of the method employed by Wilson and Heaven by which the oil is allowed to oxidise in a large glass flask containing soda-lime as absorbent of acid volatile products, and connected with a paraffin-oil eudiometer. The results given show that a maximum is reached in 9½ hours at 30° C., and when the diminution of pressure was calculated to cubic centimetres absorbed (a similar apparatus being arranged alongside as a blank), the author found no less than 41% oxygen absorption. This is in agreement with the results of Weger (*Chem. Revue*, 1898, 5, 250), wherein a gravimetric determination of increase in weight of the oil in addition to carbon and hydrogen retained by soda-lime and calcium chloride showed a result of 43.7%. Genthe also performed comparisons of "apparent oxygen value" and "true oxygen value," by a method very similar to that of Wilson and Heaven, absorptions being performed in absence and presence of potash respectively. Genthe's results are shown thus:—

	1 %	2 %	3 %
Apparent oxygen value ..	17.7	17.0	18.3
True oxygen value ..	33.7	29.7	32.3

In connection with the lack of agreement in results, the writer's experiments confirm this, and at the present point to the possibility of uneven distribution of the oil film. Many of the workers in this field have insisted on the necessity of limiting the thickness of the film to about 1 mgm. per square centimetre. It may be mentioned that Krumbhaar (*ibid.*) also performed an oxygen absorption by a gravimetric method, the volatile products being fully oxidised to carbonic acid and water by passage through a tube containing copper oxide heated to redness, and being retained in the usual way. He failed, however, to show agreement with the result obtained by his volumetric method, and only recorded 20.6% absorption.

The writer's observations have pointed to the existence of volatile products not of an acid nature, an inflammable gas being found after the gaseous portion of the residual gas had been retained by soda-lime. This gas is at present undergoing examination. Its presence would naturally tend to further increase the actual oxygen absorption of the oil.

Turning now to a consideration of the calculations in Wilson and Heaven's paper, in which the authors claim to show agreement of the experimental results with those calculated from theory, they base their calculations upon the observations of Solway and Kipping on the oxygen absorption of some unsaturated compounds, those bodies with one double bond absorbed no oxygen, those with two double bonds absorbed an amount in the equivalence of iodine to oxygen ($I_2 = O$, *i.e.*, linolic acid absorbs two atoms of oxygen), and bodies with three unsaturated linkages absorb double the latter amount ($I_2 = O_2$).

Assuming the constitution of linseed oil given by Hazura, as submitted by Wilson and Heaven, instead of the calculated iodine absorption of 208, it would work out as follows:—

5% olein of I.V. 86.2	..	..	..	4.31
15% linolin of I.V. 173.6	..	..	..	26.04
80% linolenin (and isolinolenin) of I.V.				
262.2	..	..	..	209.76
				240.11

Since these glycerides occur along with a variable quantity of saturated glycerides generally averaging 8%, the above iodine absorption would be diminished by $92/100 = 220.9$.

In view of the fact (amongst others) that the yield of dihydroxystearic acid from the mixed liquid fatty acids of linseed oil obtained by oxidation with potassium permanganate points to the existence of far larger quantities of oleic acid, and that this iodine value in no way agrees with observed facts, the constitution proposed by Fahrion is generally accepted as being a closer approximation to the truth:—

		%	Iodine absorbed.
Unsaponifiable	..	0.8	—
Saturated acids	..	8.0	0
Oleic acid	..	17.5	15.76
Linolic acid	..	26.0	47.17
Linolenic acid (and iso)	..	43.5	119.23
Glyceryl radicle (C_3H_2)	..	4.2	—
Total iodine value	..		182.16

The oxygen absorptions calculated by myself, according to Solway and Kipping's hypothesis and using the two constitutions of Hazura and Fahrion, are (linolic acid = $I.V. \times 0.063$; linolenic acid = $I.V. \times 0.063 \times 2$):—

	Hazura.	Fahrion.
	%	%
Oleic acid	Nil	Nil
Linolic acid	1.64	2.97
Linolenic and isolinolenic acid	20.43	15.02
	22.07	17.99

In the case of Hazura's constitution, the result should be calculated to the original oil, since the figures refer to the proportion of "liquid glycerides," *i.e.*, glycerides of unsaturated acids, and must consequently be multiplied by $92/100$, assuming 8% of solid glycerides, thus:—

$$22.07 \times \frac{92}{100} = 20.3\%$$

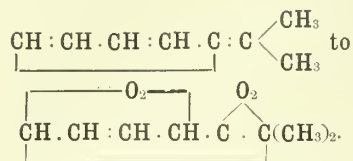
It may be well at this juncture to remark that the refutation of the statement that bodies possessing an unsaturated linkage akin to linolic acid (absorbs 4I) only absorb oxygen equal to $I_2 = O$, is afforded by a determination of the writer's, in which he found the oxygen absorption of china-wood oil (I.V. 165), by the volumetric method, to be in the neighbourhood of 31, the absorption being performed in the presence of soda-lime. Since this body contains no acid with an unsaturation of more than two linkages (4I), the application of Solway and Kipping's hypothesis does not apply, since, even assuming no oleic acid to be present, the oxygen absorption could not be more than $165 \times 0.063 = 10.4\%$.

Quite recently, Ingle (*J. S. C. I.*, 1913, 639) determined the oxygen absorption of linseed oil by passing dried air over a filter paper soaked with linseed oil to which a small addition of manganese resinate had been made in order to accelerate the drying action. His results showed that under these conditions, a maximum increase in weight was obtained, which corresponded nearly exactly with $I_2 = O_2$. He further showed that the presence of moisture tended to reduce this, and explained this on the assumption that peroxides are formed in dry air, these being subsequently decomposed at the original position of the double bonds to aldehydes, etc. In spite of the fact that the author made no mention in his paper of any investigation of the gas after its passage over the oil to determine the possible presence of volatile compounds, his hypothesis as to the nature of the addition has much to support it.

It is true that examination of any of the fractions of so-called fully oxidised oil, even "linoxyn," has failed to show the presence of a body showing no iodine absorption, such as would be demanded if the full oxygen absorption had occurred, but this is easily explainable, firstly, on account of the fact that in presence of the usual iodine chloride reagents, the peroxides would break down in a similar manner to that indicated as occurring in the presence of moisture to aldehydes which would show unsaturation, and, secondly, by the possibility of substitution by halogens occurring in the unstable peroxides by the action of iodine chloride. This point is not easy of investigation, as attempts to determine the constitution of the most highly oxidised fraction of linseed oil—Linoxyn—result invariably in a breaking down to smaller molecules, included amongst them being the so-called "oxidised acids" which, in the writer's opinion, consist of resinified aldehydes or aldehyde-acids, thus effectively baffling investigation.

Fahrion (*Die Chemie der Trocknenden Öle*) proposes to explain the mechanism of the reactions occurring during oxidation of oils by applying the analogy of Engler and Frankenstein's investigations of dimethylfulvene. This

body forms a peroxide on oxidation in accordance with the scheme :—



It will be observed that the oxidation product makes an addition of oxygen in the proportion of $I_2 = O_2$ on two of the three double bonds. Fahrion suggests a similar mechanism in the case of the unsaturated glycerides. He assumes that a double bond would always remain intact with regard to oxygen. Thus olein would absorb no oxygen, linolin would form a peroxylinolin, and linolenin a diperoxylinolenin. He further bases his hypothesis on the assumption that two different fractions of "oxidised acids" (the resinous acids insoluble in light petroleum ether and soluble in ether and alcohol respectively) correspond to the free peroxylinolic and diperoxylinolenic acids. He supports this by showing that a very fair agreement is obtained between the observed and calculated elementary composition of these two bodies.

There are many objections to this hypothesis. It has been shown, in the first place, that blown oleic acid on free dilution with petroleum ether will show insoluble "oxidised acids." The writer has, furthermore, been unable to agree with Fahrion's results in obtaining a distinct separation by fractionating out the "oxidised acids" into ether soluble and alcohol soluble portions, or, at the best, traces only of ether insoluble acid were found to occur in the acids from blown linseed oil, which should yield notable quantities of the oxidation product of linolenic acid. In the writer's opinion, it is far more probable that the oxidised acids consist of the polymerised or resinified azelaic acid residue or radical, this nine-carbon atom residue being common, curiously enough, to the three (or four) unsaturated acids of the drying oils. That such nine-carbon atom residue should remain comparatively stable to further influence of oxidation is explainable by the fact that, as a whole, it is already a fully saturated chain with no intermediate point of attack, possessing a carboxyl group at one end and probably (as a result of peroxide decomposition) an aldehydic group at the other. The writer's experience with the solid oxidised oils obtained during the manufacture of linoleum has shown that under no circumstances can they show more than about 50% of oxidised acids. According to Fahrion's hypothesis, the remaining 50% would consist of acids derived from other than linolic and linolenic acids, which in view of the considerations of the composition of the oil, is impossible. The same author does not attempt to explain the existence of the 25% or so of water-soluble acids which are obtained at the same time as the oxidised acids are separated. Such soluble acids would agree with the present writer's conception of lower acids formed as peroxide decomposition products and limited in size by their terminals which originally formed the point of existence of a double bond. Furthermore, there is no reason for Fahrion's peroxy and diperoxy acids to show abnormalities as regards constant lactone formation from lactone-freed acids. (Compare Lewkowitsch, "Oils, Fats and Waxes," article "Oxidised Acids.")

It may therefore be concluded :—

(1) It is evident that the mechanism of the oxidation of the drying oils takes place in different ways, according to the conditions under which it is performed, the primary

reaction consisting in a direct addition of molecular oxygen to form unstable peroxides, no decomposition of such, however, occurring until the saturation *approaches* near the limit represented by $I_2 = O_2$.

(2) Under conditions favouring no decomposition of the peroxides until the maximum possible is arrived at, the stability of the peroxides is such that gradual decomposition occurs with formation of volatile products. No evidence is available to determine whether the non-volatile residual products are then capable of further oxidation.¹

(3) When oxidation is performed under conditions favouring the simultaneous decomposition of the peroxides formed (moisture, heat) a greater absorption than is represented by $I_2 = O_2$ is set up. This may be due to the action suggested in (2), being an explanation, *i.e.*, the residual products resulting from the first decomposition of peroxides may be still subject to oxidation, either from aldehydes to acids or in some more complex manner.

(4) The widely differing products obtained when the drying oils are oxidised at different temperatures and under different conditions, *i.e.*, technical "linoxyn" obtained by the "scrim," "showerbath" and Taylor-Parnacott processes in linoleum manufacture, would tend to give support to these views.

It is hoped in a subsequent communication to submit data dealing with the reactions occurring after the preliminary peroxide decomposition.

NOTES ON RECENT THEORY AND PRACTICE.

By HERBERT H. HODGSON, M.A., B.Sc., PH.D.

A REVIEW of a large series of observations extending over many years is made by J. B. Cohen, who, in a paper, entitled "Position Isomerism and Optical Activity" (*Chem. Soc. Trans.*, July, 1914), criticises Frankland and Wharton's theory to explain the changes in rotatory power produced by nuclear substitution in the ortho, meta, and para positions on a side chain containing an active group. This theory, revived again by Frankland in 1912, states that on the analogy of a weight acting at the end of a lever-arm, the amount of deviation is determined by the distance of the substituting group from the active group in the following way: The centre of gravity of the benzene nucleus being at the centre of a regular hexagon, it is supposed that the ortho-substituent to the active group shifts the centre of gravity towards the asymmetric carbon of the side chain, whereas the para- has the opposite effect, the meta- being intermediate between the two, and thus, whilst the ortho-substituent diminishes, the para-increases, the magnitude of the rotation. In the unsubstituted nucleus the centre of gravity is coincident with the centre of the hexagon, and therefore acts at the end of a longer lever-arm than the ortho-substituted nucleus, but through a shorter arm than the meta-compound. According to this "lever-arm" theory, the authors anticipated the order of rotation magnitude would be: ortho < unsubstituted nucleus < meta < para, and they collected a number

¹ The super-oxidised oil of Reid (*J. S. C. I.*, 1894, 1020) may be a further decomposition product of the primarily decomposed peroxide.

of facts which appeared to support this view. Cohen argues that, if there were any truth in the notion that the rotational value was determined by the position of the centre of gravity of the nucleus in relation to the active group, then it would follow: (1) that the greater the mass of the substituting group or element, the greater would be the observed difference between the constants for the ortho- and para-isomerides, and (2) that the maximum rotation would be invariably determined by the para-substituent. Observations on the nitro and halogen derivatives of the menthyl esters of benzoic acid gave rise to the following facts: first, the meta- and para-halogen derivatives give constants which are almost identical with that of the unsubstituted ester. In the case of the nitro derivatives, whilst the rotation of the para-compound is almost identical with that of the menthyl benzoate, those of the ortho- and meta-derivatives are not less, but greater, than the rotation of the para-compound; second, the ortho-substituent produces in all cases, except in that of the iodo-benzoic esters, the largest deviation from the constant of the unsubstituted ester; thirdly, the element iodine, which possesses the greatest mass of the four halogens and might not unreasonably be expected to produce, according to the theory, the most marked effect in the rotations of the position isomerides, actually exhibits the least, at the temperature of observation, the constants being substantially the same as that of the unsubstituted ester. The menthyl esters of the toluic acids and the alkyloxy derivatives, which were introduced by Frankland in support of his theory, cannot be regarded as affording satisfactory evidence, and Cohen states that, so far as his very numerous observations go, there is not a single series of position isomerides which is in harmony with Frankland's theory. Cohen, although attempting no mechanical conception of the relation of structure to rotation, concludes that the element or group lying nearest to the active group produces the greatest effect, which, according to the nature of the group, may be an increase or decrease in the rotation value, and that this value approaches the normal for the unsubstituted compound, the further the substituent is removed from its sphere of influence, *i.e.*, from its proximity to the active group.

J. N. Rakshit (*J. Amer. Chem. Soc.*, 1914, 36, 1221—1222) failed in his attempt to prepare tetra-amino methane by the reduction of tetra nitro methane with nickel-coated zinc and hydrochloric acid and also by tin and the latter acid, ammonia and guanidine being produced in each case. Two evidently appears to be the limit of the attachment of amino-groups to a single carbon atom, the additional nitrogen being usually present as a cyano- or imino-group.

The coupling of phenols and phenolic ethers with diazo compounds is the subject of an important paper by Meyer, Irschick, and Schlösser (*Ber.*, 1914, 47, 1741—1755). It has recently been shown that, contrary to the generally accepted idea, not only phenols, but phenolic ethers can couple with diazo compounds, the products being alkyloxyazo-compounds. Investigation now shows that, as a rule,

the introduction of negative substituents into the diazo-compounds increases their activity towards coupling with phenolic ethers; thus the diazo body from 2:4-dinitro-aniline couples readily with anisole and phenetole, and immediately with the ethers of resorcinol and *a*-naphthol, whilst the nitro-benzene diazonium compounds do not couple with the latter class of substance, although they do so easily with the former class, and benzene diazonium salts couple still less readily. On the other hand, the introduction of negative groups into the phenolic ethers diminishes their tendency to coupling, whilst positive radicles, especially alkyloxy- and alkyl groups, in the meta position, increase the tendency.

An interesting contribution to the theory of wool dyeing is made by K. Gebhard (*Zeitsch. angew. Chem.*, 1914, 27, 297—307), who, from an investigation of the products obtained by the action of alkaline solutions on wool, finds that the insoluble residual substances are essentially responsible for the fixing of dyes. A comparison of the chemical-dyeing properties of wool with those of the decomposition products of proteins has shown that phenyl glycine and anthranilic acid behave in several respects similarly to wool. In the expectation of an increase in molecular weight accentuating this similarity, experiments were made with anthranoylanthranilic acid, with the result that this substance was found to resemble wool very closely in its behaviour towards dyes. An investigation into the nature of the groups which impart to wool its capacity for fixing dyes has also been undertaken, and results indicate the dyeing of wool by basic dyes to be conditioned by the presence of the carboxyl group in the wool. Should the hydrogen of the latter group be replaced by an alkyl radicle, basic dyes have no action on the resulting substance. With acid dyes both the amino and carbonyl groups appear to be concerned, and, if one of these groups be rendered inactive, a reduction in the colouring capacity of the acid dyes is experienced.

L. Vignon (*Compt. rend.*, 1914, 158, 1421—1424) has made a comprehensive study of the action of solvents on coal. The soluble matter has been determined, when extracted in the cold and at the boiling point, by alcohol, ether, benzene, toluene, aniline, and nitro-benzene respectively. Aniline exerts the greatest solvent action and appears to dissolve about 26% of good gas coal, but only 2% of a poor gas coal. The soluble matter is precipitated on the addition of acid. Analysis of the soluble and insoluble portions showed that the soluble portion is richer in hydrogen, poorer in ash, and gives an agglomerated bulky coke, whilst a powdery coke is afforded by the insoluble portion. Pyridine and quinoline were also tried as solvents at their boiling points, the latter being found to possess a solvent action almost three times as great as that of the former.

W. E. S. Turner and C. T. Pollard (*Chem. Soc. Trans.*, July, 1914) have contributed an important paper on the influence of solvents on molecular weights. Since any valid interpretation of the results of molecular weight determinations in

solution ought to be based on a knowledge of the part played by the solvent, the authors have found that, apart from its dielectric character, a solvent exerts a specific effect depending on its constitution in a manner as yet unknown. The general conclusions arrived at are: (1) Salts must be regarded as associated substances, much more so than organic bodies containing hydroxyl or other complex-producing group. (2) The molecular weight of a dissolved salt depends mainly on the dielectric constant of the solvent, being high in solvents of low dielectric constant and low in those of high. Association of a salt becomes noticeable, as a rule, in solvents of dielectric constant less than 18.0. (3) Molecular association and electrolytic dissociation are part of the same general phenomenon. (4) Deviations from the rule embodied in (2) may occur, due both to the specific influence of the solute or the solvent. Deviations from the second cause are to be found most prominently among solvents of low dielectric constant. (5) Temperature has a considerable influence on the molecular weight of a salt in solution. (6) Simplification of the molecular state of an associated substance does not occur on solution in an associated solvent unless the solvent has also a high dielectric constant.

Jones and Lapworth (*Chem. Soc. Trans.*, July, 1914) have made an interesting application of *α*-bromonaphthalene to the determination of water in moist alcohol. Finding that the *α*-bromonaphthalene as purchased was always in a decidedly impure condition, they devised a means of purification for dealing with large quantities of material. Commercial *α*-bromonaphthalene was fractionally distilled in a current of steam so long as the naphthalene odour could be detected or until the distillate no longer deposited crystals at laboratory temperatures. The residue was then separated from the water, dissolved in absolute alcohol, the whole thoroughly cooled, and seeded, if necessary, with a little solid. The mass was then transferred to a Büchner funnel and freed as rapidly as possible from the mother liquor. By repeated cooling of the mother liquors, collection of the deposits, and recrystallisation from absolute alcohol, large fractions may finally be obtained. The alcohol is removed in a current of steam, the last traces of water eliminated by shaking the liquid with calcium chloride, and a stream of dry air or carbon dioxide finally passed through it at 100°C. The usual method of determining the composition of mixtures of water and alcohol is by observations of their densities, but other methods have been devised including some depending on observations of clearing or clouding points of mixtures with other liquids. Thus Curtis tried toluene, Siderski used ether, whilst petroleum has also been suggested and applied successfully. The present authors found such a method based on clouding points with a third component as most suitable, *α*-bromonaphthalene being the most efficient substance tried. In working, about 6 c.c. of the alcohol-water mixture are introduced into a small vessel fitted with a thermometer and a small weighed amount of *α*-bromonaphtha-

lene added, a rotatory motion being given to ensure admixture. By immersion in a beaker of water, the temperature can be slowly lowered until clouding occurs. Just above the critical point the liquid gradually assumes an opalescence, especially when large proportions of bromonaphthalene are present, but this appearance is easily distinguished from that at the true critical point, when the liquid suddenly becomes opaque. The exact temperature at which this opacity appears is noted by a second thermometer in the cooling vessel, care being taken that at the clouding point the temperatures registered on the two thermometers do not differ by more than a fraction of a degree. The error in the percentage of water was never found to be greater than 0.03.

PERSONAL AND OTHER NOTES.

DR. THOMAS H. GLENN, formerly in charge of the pathologic and bacteriologic laboratories of the Northwestern University, Chicago, has been placed in charge of the clinical and Röntgen-ray laboratories now being installed at Fort Dodge.

Dr. Friend E. Clark has resigned his position as professor of chemistry in Center College, Danville, Ky., to become professor of chemistry in West Virginia University.

Irene Hunt Davis, instructor in chemistry at the University of Washington, has been promoted to be assistant professor of chemistry.

The death is announced of Mr. Edward Riley, one of the pioneers of accurate methods of analysis for iron and steel works' products and raw materials. From 1853 to 1859 Mr. Riley was chemist at the Dowlais Iron Works in South Wales. He did much analytical work in connection with ferro-manganese, spiegeleisen and manganese ores. He was recently awarded the Bessemer gold medal in recognition of his work in analytical chemistry and metallurgy.

The President of the Institution of Gas Engineers, Mr. John Bond, has been requested to assist the Chemical Products Committee, he being specially well versed in regard to the raw materials requisite in dye-manufacture.

Dr. Morris Loeb, president of the New York Chemists Club, who died in October, 1912, left an estate of \$2,148,042, the bulk of which goes to his widow during her life, but later to be divided among various institutions.

Dr. J. B. Leathes, F.R.S., Professor of Pathological Chemistry at the University of Toronto, has been offered the chair of physiology at the University of Sheffield, rendered vacant by the acceptance of Professor J. S. Macdonald of the chair of physiology at the Liverpool University.

Dr. A. W. Stewart has been appointed lecturer in physical chemistry at the University of Glasgow, having resigned his post at Queen's University, Belfast, for that purpose. He takes the position occupied by Professor Soddy who, as previously announced, has gone to Aberdeen University.

Mr. H. Patterson has been appointed part time lecturer in physical chemistry at the Battersea Polytechnic.

SURFACE TENSION AND SURFACE ENERGY AND THEIR INFLUENCE ON CHEMICAL PHENOMENA.

By R. S. WILLOWS, M.A., D.Sc., and E. HATSCHKE.

CHAPTER X.

It has been shown in the preceding chapters that the distribution of the solute particles in a solution depends, not only on the surface tension, but also on the electrical charges which may exist on the particles. This factor will have especial weight in the case of electrolytes, where the ions are known to be charged, and certain effects of surface tension may be seriously modified, if not altogether masked. It is to the consideration of these electro-capillary effects that we now turn our attention. To form a mental picture of the electric field it is convenient to follow a method originated by Faraday and now used by all physicists. If a charged body is held near an oppositely charged or electrically neutral body mutual attraction occurs, exactly as if the two were connected by tense elastic threads. Faraday supposed that imaginary lines, in a state of tension, connected oppositely charged points; these he called lines of force. Many properties of electric charges can be foretold if it is assumed: (1) that the lines of

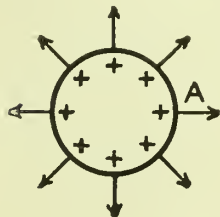


FIG. 13.

force are in a state of tension; (2) that they repel each other sideways. Thus if a charge is put on a metal sphere at A (Fig. 13), lines of force are concentrated on this point, but, owing to their mutual repulsion, they spread sideways until all the pressures are equal, and the charge is uniformly distributed over the surface. As the lines are in a state of tension, it is clear, from the figure, that the sphere will tend to expand on account of the outward pull. If the sphere were a liquid drop, its surface tension would cause it to assume a minimum surface area; the effect of the electric charge is to oppose this, and the net result is that *the liquid behaves as if it had a reduced surface tension.*

This result introduces important modifications when a saturated vapour is condensing into liquid drops. Surface tension, as has been shown in Chapter III., makes the initial stages of condensation more difficult; but if it can be arranged that the droplets form on a small electrically charged body, the deterrent effect of the surface tension can be greatly reduced and condensation is accelerated. This has been beautifully shown by C. T. R. Wilson in a series of experiments. Air, saturated with water vapour was confined in a bulb and, by means of a piston arrangement, it could be made to expand suddenly; the temperature, therefore, fell and liquid condensed on any dust particles that happened to be present (Chapter III.). The fog so produced was allowed to settle, carrying the dust down with it.

After several repetitions all the dust was removed and no fog was produced except with large expansions. An X-ray bulb or a small amount of radium was now caused to send rays through the gas. (These are known to produce electrified particles, or ions.) A much smaller expansion now produced a very dense fog. Most vapours condense the more readily on positively charged ions; water forms the chief, if not the only, exception to this rule.

The presence of gaseous ions will make it difficult to dry a gas thoroughly. This is perhaps best seen from energy considerations. If Q is the charge on a drop of liquid of radius R , the electrical energy is $\frac{1}{2} Q^2/R$. As the drop evaporates R diminishes but Q remains the same, *i.e.*, evaporation increases the electrical energy; hence the presence of the charge makes evaporation more difficult. Surface tension, as we have seen in Chapter III., promotes it. At some stage of the process there will be equilibrium between the two effects and the drop will persist. Owing to the universal distribution of radioactive substances gaseous ions are always being produced in the atmosphere, and moisture condenses on them. Once formed, the drops persist, with a radius of about 3×10^{-7} cms. at room temperature. To reduce the radius by one-half by evaporation, it has been calculated by Sir J. J. Thomson that the surrounding air must be dried so completely that the moisture present is only 3×10^{-16} of that required to saturate it. Professor Baker has demonstrated the efficiency of moisture in promoting chemical reactions; the figures just quoted show the difficulty of securing perfect dryness. Apparently the last stages of drying are due, not to the removal of gaseous water vapour, but rather to the entanglement of the more persistent drops in the drying agent. If this is really so, the final traces of moisture could be more quickly removed by placing the gas in an electric field, and so driving the charged drops on to the absorbent!

In emulsification a large amount of surface energy is produced owing to the great surface area of the disperse phase; the emulsion is more easily produced if this energy is reduced by the employment, as continuous phase, of a liquid having a low surface tension, like soap solution. The lowering of the effective surface tension by the electric charges, usually present on the small drops, will also assist the process. The increased stability of an emulsion or a suspension due to these charges has already been mentioned.

The effect of electrification on surface tension can be directly measured by means of the capillary electrometer (Fig. 14). A glass tube A, drawn out below to a fine conical capillary, is connected by rubber tubing to a movable reservoir; each contains

mercury. The capillary dips into a solution of electrolyte, below which is a further layer of mercury. The mercury surface in the narrow tube is very convex downwards, and, owing to the surface tension mercury-electrolyte, can support a pressure $2\sigma/a$, σ being the interfacial tension, and a the radius of the tube at the given point (Chapter III.).

If σ is increased the equilibrium is distributed and a larger head of mercury must be employed to keep the meniscus at the same level. The length of the mercury column in A is evidently proportional, in these conditions, to the interfacial tension mercury-electrolyte. The mercury side of this surface can be charged with negative electricity by the device shown in the figure. A current is sent from a battery through a thin wire BC, the positive pole being joined to B. This point is also connected to the mercury at the bottom of the beaker. A wire D, sliding along

FIG. 14.

BC, is connected to the mercury in A. As D is moved from B to C it is clear that the mercury meniscus receives a larger negative charge from the negative pole of the cell, the corresponding positive charge moving upwards through the electrolyte from the other pole. An increasing potential difference is thus established across the mercury-electrolyte surface, until the resistance is broken down, current passes, and electrolysis begins. The surface tension

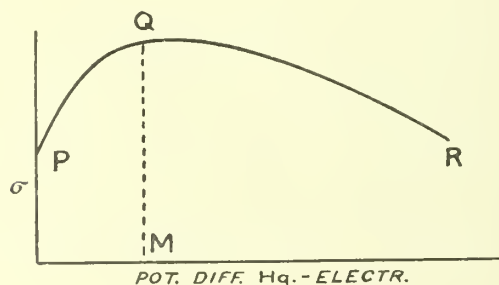


FIG. 15.

corresponding to any potential difference is measured in arbitrary units, by the height of the column in A. The curve in Fig. 15 shows how σ depends on the

potential difference between the mercury and electrolyte. It reveals, at least, one unexpected feature. Since an electric charge apparently lowers the surface tension, we should expect a gradual decrease as the potential difference increases, while, in fact, σ first increases to a maximum before finally diminishing. The maximum at Q corresponds to a potential difference between B, D of 0.926 volt for Hg — normal H_2SO_4 . Either previous ideas of the influence of a charge on surface tension must be revised, or a new factor must be looked for. Helmholtz adopts the second alternative. He supposes that there is a double layer of electricity at the mercury-electrolyte surface under normal conditions, the mercury being positively and the adjoining layer of electrolyte negatively charged.

Evidence in favour of such a double layer can be gathered from other, purely electrical, phenomena. Hence at the beginning of the experiment, corresponding to the point P on the curve, we are dealing not simply with the interfacial tension Hg — electrolyte but with a tension modified by the presence of this double layer of electricity. If σ is the surface tension when there is no charge, then, holding to our previous views, the tension σ , when a double layer is present, is less than σ . As the mercury is supposed to have a positive charge, initially, the effect of giving it a negative one is to annul partially this primary charge and so to increase σ , until, at Q, the surface is electrically neutral and the tension has its highest value. Beyond this point, as the potential between B, D is further increased the mercury becomes negatively charged, a new double layer is created in the reverse direction, and σ decreases in the usual way.

When there is no double layer present—corresponding to Q according to Helmholtz—the liquids are said to be iso-electric. This condition possesses considerable chemical interest in connection with the coagulation of precipitates or of bacteria. A finely divided precipitate is the seat of considerable surface energy; coagulation reduces this by decreasing the surface area, and the reduction is all the more pronounced the greater the interfacial tension. Hence a large surface tension promotes coagulation, and should therefore be most efficient at the iso-electric point. As the position of this point can be altered by suitable additions of acid or alkali, it should be possible to attain the best conditions for the purpose.

There is considerable evidence that whenever two immiscible substances are brought together a double layer at the interface results, but recent work has made it doubtful whether, in every case, the iso-electric point corresponds with the condition of maximum surface tension.

It is an interesting question whether the effects just described are different for the anions and cations. The Helmholtz theory neglects this factor and ascribes them entirely to the stresses in the lines of force, independently of the direction of the latter. If this were true, starting with the surfaces uncharged (as at Q), equal positive or negative charges on the mercury should lower the surface tension by the

same amounts, and the curve PQR should be symmetrical round Q. Experiment shows that this is not the case, but the branch PQ is steeper than QR. There is therefore a specific action depending on the nature of the ion. Along PQ the electrolyte surface is negatively charged, according to the Helmholtz theory of the initial double layer (*vide supra*), that is the anions are more effective than the kations in lowering the surface tension. Van Laar has revised Helmholtz's calculations, taking into account this new effect, and finds excellent agreement with the measurements of S. W. J. Smith. These experiments are given later.

As regards the origin of the double layer the Helmholtz theory gives no information, but several other theories have been formulated. Modern electrical theories suppose every conducting substance to contain large numbers of negatively charged ions, called electrons, which are exactly alike no matter in what substance they are found. When two substances, containing different numbers of electrons, are brought together, there is a redistribution between the two; that body which loses negative electricity, of course, becomes positively charged, while the other becomes negative. This would account qualitatively for the layer, but the theory is insufficiently developed to make possible a quantitative test. The double layer is evidently due to selective adsorption of the ions; in the case we have considered it is the negatively charged ion that is most readily abstracted from the electrolyte. The object of any theory must be to explain why this selective adsorption takes place.

Another theory which has given rise to much research is due to Nernst. As it is closely connected with the question of the iso-electric point it must be considered briefly. When a solid like zinc is placed in a liquid, Nernst supposes there is a pressure, of the nature of an osmotic pressure, tending to force the zinc ions into solution. This he calls the solution pressure. Zinc being electro-positive, its ions are positively charged; the liquid thus becomes positively and the zinc, on account of its loss of positive ions, becomes negatively charged. A difference of potential between solid and liquid is thus created, and, as the ions are attracted to the negatively charged zinc, a double layer is formed at the interface. When zinc ions are already in the liquid they may be deposited on the zinc instead of more going into solution. If these effects take an appreciable time to establish themselves, it should be possible, by tests made immediately after the contact of solid and liquid, to get rid of the influence of the double layer, and zinc and liquid would then be at the same potential. This is the principle of the dropping electrode in which the zinc is replaced by mercury. Suppose, for example, in the capillary electrometer (Fig. 14) that the mercury falls out of tube A in a fine jet, which breaks into drops before the double layer is formed. Mercury and solution are then at the same potential, but the double layer is formed as usual over the mercury at the bottom of the beaker. Hence if the potential difference is measured between the mercury in the funnel and

that below the solution, there would be found the potential difference across this double layer. This should equal the potential difference required to produce the maximum surface tension when the electrometer is used in the ordinary method already described. This is found to be the case if the jet is in air and breaks into drops in the surface of the liquid. It would thus appear that from observations of surface tension there can be found the difference of potential between mercury and electrolyte, the required result being the E.M.F. at which the surface tension is a maximum. S. W. J. Smith's experiments show that this is not generally true, and that the potential difference between mercury and electrolyte is not necessarily zero when the surface tension is a maximum.

(To be continued.)

BRIQUETTED OR "PATENT" FUELS.

By J. G. DAVIS, B.Sc. (Eng.), and A. G. HAWKER.

THE "briquetted fuel" industry is of increasing importance, in view of recent progress, both in this country and on the Continent. The home manufacture of artificial fuels, so-called "patent" fuels, is confined to South Wales, and nearly the whole of the million and a half tons there produced annually is exported.

It is only of comparatively late years that the possibility of utilising the "slack" or small coal as an effective fuel has become recognised, and the waste previously allowed in this connection reduced.

The production of slack in conjunction with block coal is, of course, unavoidable, and though the proportion of small coal naturally varies with the nature of the working and of the seam, this not infrequently reaches 70 % of the whole coal brought to the surface.

The use of this both for coke and for briquette manufacture when of a bituminous or semi-bituminous nature, is, of course, far from being a new departure in this country or elsewhere, but commercial economy has only recently been attained in the processes employed in the production of "patent" fuels, and in the provision of an efficient binding agent or agglomerant.

Taking a broad view, the object of such manufacture is the production of briquetted coal, peat, lignite, and the like by moulding the material into blocks of convenient size for steam-raising or domestic purposes by means of suitable binding agents which are made effective by the application of mechanical pressure, and this with a minimum of waste both in the raw material, the energy utilised in the various processes, and, for the satisfaction of the consumer, in the final combustion of the fuel briquettes.

The properties desirable in a binding agent may be generally regarded as minimum smoke and ash production, combined with cheapness, good binding, and waterproofing or "weathering" qualities.

These are scarcely obtainable simultaneously in

any one known substance, and the bulk of the numerous patents taken out during the last forty or fifty years in connection with the patent fuel industry have claimed improvement in this direction by the use of such substances as coal-tar pitch, residues from petroleum, or asphaltic pitch, water gas-tar or producer gas-tar pitch, whilst starch residues, sulphite liquor residues from paper mills and certain inorganic substances form quite a fair percentage of the binders or "cements" suggested or actually employed.

The objection to many of the inorganic mixtures here proposed is mainly on the side of the consumer, viz., undue increase in the ash-content of the briquetted fuel, whilst the commercial success of many of the enterprises employing binders of a resinous or glutinous nature has been opposed by the comparatively high market price of such substances.

The manufacturers in this country employ pitch (the residual product of the distillation of coal tar) almost exclusively as a binding agent, and occasionally this is mixed with starchy material.

When mixing the fine coal with the binder, a fairly high temperature (sometimes produced by injected superheated steam) is employed.

The proportion of ground pitch will vary with the nature and quality of the coal to be briquetted. A high degree of mechanical pressure, generally produced by steam or hydraulic machinery, is then required for moulding the mixture into blocks of the desired shape and size.

To lessen the smoke evolved upon subsequent combustion the briquetted fuel is sometimes subjected to a partial "coking" process before leaving the factory.

With regard to the percentage of binder needed, it is evident that a "slack" that cakes easily of its own accord would require a smaller proportion of binding agent than would a non-caking fuel. It may be remarked that the presence of free carbon in pitch materially lessens its binding value, that the pitch should therefore be of good quality, and that an average proportion of pitch binder is then about 6%.

Proceeding to the description of a typical coal briquetting factory, that of the Star Patent Fuel Co., of Cardiff, is arranged as follows: The small coal is conveyed by rail from the collieries, the contents of the trucks being emptied by steam "Billy-blocks" into a "tip," whence they are carried to a "screen" by means of a chain bucket-elevator. The "screen" revolving at a slow speed, retains the nuts of coal and allows the fine dust to pass through. The nuts leave the surface of the screen by centrifugal action through apertures around the circumference, and fall thence through shutes into trucks, which convey them to the boiler house where they are used as ordinary fuel for the steam supply of the works. The dust, on the other hand, is transmitted to an apparatus termed the "mill" by means of a second chain bucket-elevator. This "mill" is a device for intimately mixing together the pitch binder and the "slack" (small

coal from the reservoir beneath the "screen" and broken pitch from the pitch crusher being fed simultaneously into the machine) and, incidentally, for breaking the pitch into still smaller pieces than have been formed by the "crusher."

In mechanical principle the "mill" is simply two discs of iron spaced a certain distance apart, united by a series of 1-in. diameter iron bars spaced equally around the circumferences, to one of which discs is fixed a sleeve driven by a belt pulley. Inside the first "barred-wheel" is a second one, consisting of two smaller iron discs similarly connected together around their circumferences, but spaced a smaller distance apart, and mounted on a shaft running concentrically with the sleeve of the first wheel and passing through it. This shaft is driven by a belt pulley in the opposite direction to the sleeve and larger wheel.

The action of the oppositely rotating sets of bars is thus one of churning and grinding upon the ingredients of the mixture which are being forced through the spaces, outwards, between the bars connecting the larger pair of discs. The mixture of coal and pitch passes from the apertures between the bars of the "mill" to the lower parts of the casing, whence a bucket-elevator conveys it to a shute, and thence to "heaters."

It has been stated that the pitch is fed to the "mill" direct from the "crusher," and in this connection the proportion of pitch fed in may be conveniently varied, according to the percentage of binder which is known to be required with the quality of "slack" under treatment, by the adjustment of either the size of buckets employed on an endless chain for delivery of the pitch, or, which amounts to the same thing, by adjusting the speed of working of the chain bucket-elevator which feeds in the pitch binder.

The ingredients having arrived, in their correct proportions, at the intake of the "heaters," a brief description of the latter is necessary. They generally consist of horizontal cylinders pierced axially by a square shaft, the circular ends of which are supported in bearings of the plummer-block type. The shaft is driven at a suitable speed (commonly some 60 revolutions per minute), and is fitted throughout the length of its square section with knives attached to arms threaded on same, collars of suitable width being set between adjacent arms as distance pieces. Each of these single arms is set at right angles to the next, so that in a horizontal distance equal to that between four arms we have four knives, one at each 90 degs. In this connection it is evident that the square shaft is simply a convenient device to prevent rotation of the arms upon it, and to facilitate the right-angled setting of the knives. The whole shaft with arms and knives attached is thus rotated inside the fixed "heater-cylinder" already mentioned by means of toothed gearing.

The "heater cylinders" themselves are held at rest and are surrounded by suitable furnaces, or, alternatively, by steam superheating devices, whilst the crude mixture of pulverised coal and pitch from

the "mill" is forced axially into these ovens from the chute which receives the contents of the bucket-elevator already mentioned.

The pitch, softened by the heat, is churned up by the system of rotating knives, and is more perfectly mixed with the "slack" as the whole of the mixture becomes evenly heated throughout, during its helical passage from the feed to the discharge end of the "heater cylinder," whereupon the patent fuel paste or "muck," as it is called, falls into the "heater" pit. This forms the intake of a further chain bucket-elevator, which conveys the paste or "muck" to a "mixing tank." The latter consists of a suitable vessel in which knives revolve with a vertical shaft. There are commonly two knives fixed close to the bottom of the external stationary vessel, and two further knives set at right angles to these set some 3 or 4 feet higher. The vessel, which is usually an iron tank, partially overlaps the "pressing-table" in plan, and after further mixing in the manner indicated the "muck" or paste falls into moulds arranged for its reception in the table, the two lower knives sweeping off the excess and thus providing for the same amount of charge in each mould. The apparatus may be arranged to fill one or more moulds in the pressing table simultaneously; the moulds are then brought by a suitable horizontal translational motion directly under the respective blocks or stamps arranged for compressing their contents into the shape of the moulds. These stamps are actuated by a large steam or hydraulically operated ram, which is common to them all, and a further rotation of the pressing table containing the now compressed blocks in their respective moulds brings the latter directly over delivery openings. The discharge of the briquettes through these delivery slots is arranged to be automatically controlled by the pressing ram.

It would appear to the casual observer that the employment of heavy pressures in the manufacture would secure increased cohesion and less liability of the briquettes to break up on handling, and, whilst there is considerable range of opinion as regards the pressure intensity necessary, it must be borne in mind that the range of values specified by various manufacturers—viz., "from 12 cwts. to 2 tons per sq. in. on the surface of the briquette"—probably does not take into account the differences in the quality of the ingredients or of the temperatures at which the pressure is applied. It must be remembered, however, that the application of a pressure in excess of that just necessary to secure solidity has the effect of crushing the particles of coal, thereby reducing them to a fine dust which requires more binder to prevent crumbling, and at the same time burns less freely than a fuel composed of larger particles. In connection with this it may be stated that the size of coal for best results in combustion should be such as to pass through a mesh of between $\frac{3}{16}$ and $\frac{1}{4}$ in., though such briquettes have a somewhat rough appearance.

It will be evident that the value of the finished product is very materially influenced by the mechanical processes involved in the manufacture.

The following tests of samples of various makes of coal briquettes have previously been recorded by a contributor to the "Engineering Supplement" of the *Times*, and will serve to indicate the differences in composition and in the industrial value of such fuel:—

Very poor coal briquettes showed 2.20% moisture, 16.80% ash, 81.00% carbon, hydrogen, combustible sulphur, oxygen and nitrogen, with a net calorific value (as determined by the Mahler bomb calorimeter) of 11,286 B.T.U., and an evaporating power of 11.68 per lb.

Average good briquettes, of specific gravity 1.20 "Anchor" brand, showed 1.12% moisture, 9.92% ash, 80.45% carbon, 3.99% hydrogen, 0.82% combustible sulphur, 3.70% oxygen and nitrogen.

The total percentage of volatile matter was 12.88%, calorific value 13,529 B.T.U., and evaporative power 14.00 per lb.

When immersed in water, the absorption thereof by the inside portions of the briquettes in a broken state was some 3% after five days, rising less and less rapidly to 11% after twenty-one days, subsequently to which practically no further water was absorbed.

The outside surfaces normally presented to water when the briquettes are immersed whole are probably more waterproof than the above figures indicate, and it is interesting to note that the cohesion of the material was practically unaffected by such immersion tests as here quoted.

As one might expect from the nature of the process, the product is open to inconsistency, and such figures are subject to variation for the same brand of fuel. The moisture, for instance, fell to 0.7%, the ash to 4.7%, the volatile matter to 15.2%, the calorific power rising as high as 14,350 in a series of tests of the "Anchor" briquettes above considered.

The size of the briquettes usually increases as the output of the briquetting press rises. For standard plant of the type illustrated in Fig. 2 the "5-ton machine" makes some 10 cwts. of briquettes per hour, measuring $3\frac{1}{4}$ ins. $\times$ $3\frac{1}{4}$ ins. $\times$ $2\frac{3}{4}$ ins., and weighing about $\frac{3}{4}$ lb. each, whilst the "200-ton machine" turns out 20 tons of briquettes per hour, each measuring 10 ins. $\times$ $6\frac{3}{4}$ ins. $\times$ $5\frac{1}{2}$ ins. and weighing some 16 lbs.

The price of the briquettes on the works appears to run from some 15s. to 20s. per ton in South Wales, the figure being influenced to some extent by the facilities for conveying both the finished product and raw materials on the works itself as well as by quality, operating, and establishment costs. The importance of up-to-date elevating and conveying plant in modern industry has been dealt with by one of us in a previous article, and in the briquetting works such facilities are essential.

In connection with "briquetting," it may be remarked that processes and machines similar to those above described for coal are often advantageously applied to the briquetting of copper and silver ore, etc., suitable modifications being made according to the binding material locally available.

The employment of a certain proportion of meal

and lime as a binder for small coal in hot climates has been also fairly successful where the briquettes so made could be burned with a strong draught, or with about equal quantities of large coal, this applying to cases where pitch and like substances have been locally unobtainable, or where the high temperatures prevailing made the use of pitch troublesome.

The calorific value of briquettes so made is, naturally, materially below that for pitch binders, or for binders obtained from petroleum residues which tend to produce a briquette of greater efficiency, owing to the high calorific power of such binders themselves.

The recent steps made in connection with the briquetting of peat on the Continent are also of particular interest, and there is no doubt that the increased storage and handling facilities afforded by "patent" fuels are greatly in their favour for industrial and domestic purposes, and that the gradual perfecting of "briquetting" processes is another indication of the strong tendency of modern engineering to profitably employ all "scrap" and residues, and to reduce waste to a minimum.

ENGINEERING NOTES.

By R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

Electrolytic Iron Manufacture.

Professor Guillet submitted a paper dealing with this subject to the Iron and Steel Institute a short time ago, which for many reasons should be extremely interesting if the manufacture can be carried on on anything like a commercial basis. The costs, apart from interest on capital and renewal funds against depreciation, are chiefly represented by two items, the cost per unit of electrical energy and the cost of the pig iron, and these two items, indeed, are reckoned by Professor Guillet to be the main price factors in any case. For the purpose of his paper he takes the first as $\cdot 1d.$ per unit, a Swiss figure, and indeed, all his electrical views are based on a water-derived unit; if this extremely low figure includes the maintenance and repairs of the electric plant and wages and interest charges it is a very satisfactory point, but at once localises (if so low a sum is necessary) the industry, geographically, to Switzerland, Sweden and Norway, and some parts of the States. Unfortunately, the cost of pig iron, at most places where water-derived energy is really cheap, is high and his average figure for pig in these districts of about 70s. seems a little optimistic. The rate of production according to Professor Guillet seems to vary inversely, as the current density, for, with 93 amps. per square foot he reckons on a production of 2 tons per kilowatt year, whereas with about half that density he thinks 4 tons can be produced.

Tubes have already been deposited by this process and have proved in many ways exceedingly satisfactory. They were turned out by Messrs. Bouchayer and Viallet at the rate of about a gross a day, and their average size was 13 to 14 feet long and of a thickness of $\cdot 06$ to $\cdot 25$ ins., on diameters ranging from $3\frac{1}{2}$ ins. to 8 ins. Some tubes tested at 1,200 lbs. per square inch (tubes 4 ins. diameter, and $\cdot 03$ ins. thick) showed a uniform swelling with no tendency to crack.

On removal from the baths and mandrils the tubes are

inclined to be brittle, but on annealing for 4 or 5 hours at a temperature of about $900^{\circ}\text{C}.$ the metal becomes soft and ductile and gives a tensile break of about 19 to 20 tons to the square inch with an elongation of about 40%.

If sheets could be commercially produced by this metal there should, as Professor Guillet points out, be a fine field for them in electrical work, owing to the great uniformity and purity of the product, together with a great reduction in hysteresis and increase in permeability. Dr. Max Breslauer on this subject thinks the saving in weight in transformers might amount to as much as 35%.

Iron made by this method into sheets would, if commercially possible, probably present some very attractive features, but the present unfortunate situation is likely to delay attempts in this direction very seriously.

Fire Extinction in Oil Tanks.

In Volume 35 of the *Journal of the American Society of Mechanical Engineers* there is a paper on this subject by M. E. A. Barrier.

In his opinion there are only two satisfactory methods of dealing with fires in such circumstances: (1) by diluting the burning liquid with an inflammable extinguishing agent which is miscible with it; or (2) to blanket the burning oil with some suitable solid or gas which will lie on the surface in spite of the burning and consequent frothing. The author mentions a case where 5 tons of burning crude naphtha, and another in which 13,000 superficial feet of burning tar were extinguished by such methods; but, as he points out, a considerable number of fairly intelligent people were required for these feats. Several patent extinguishing compounds, the natures of whose compositions are not mentioned, are described in their effects, but of those which are under no disguise the two most favourably mentioned are sawdust mixed with sodium bicarbonate (an example of number (2)), and carbon tetrachlorine (an example of number (1) above). Clearly, the first mentioned is by far the cheaper, and equally clearly it must be next to impossible to apply it to the middle of any oil conflagration of large superficial area. In fact, this must be the chief difficulty with any non-liquid method, and all liquids having the required properties will probably be fairly expensive, and the initial outlay in keeping a fairly large stock of what may never be required and an expensive pumping apparatus will deter many from affording their goods this protection.

Paints for Structural Steel.

A paper appears in the "Proceedings of the American Society of Civil Engineers" (Volume 39, 1913) on various covering paints for such a purpose. About seven years ago the Havre de Grace bridge was painted with a considerable variety of coverings, and the American Society for testing materials appointed a committee to make a final report on these about two years ago. Three of the paints proved excellent, two of them being pure red lead in oil, and the third red lead and about 15% of silicate finely powdered.

Several points appeared from the report. Pure red lead in oil is the best paint for this class of work apparently, though it is rather a slow drier, but the litharge from which this paint is made is not the valuable part of the paint as was formerly supposed; in fact, the more complete the conversion to red lead the better, and the finer ground the better also. Other points appearing were that oxide of iron is neither a very good or very bad basis for structural paint, but oxide of manganese is distinctly bad. This latter point seems fairly obvious, especially if any moisture found its way into or under the coating of the steel.

REVIEWS OF BOOKS.

"STORAGE OF PETROLEUM SPIRIT." By A. Cooper Key. C. GRIFFIN & Co., LTD, 1914. Pages 126 + ix. Price 2/6 net.

This small volume has been carefully compiled for the use of those who have to inspect stores of petroleum and calcium carbide. The author is chief inspector of explosives, and the volume deals chiefly with the administration of the Petroleum Acts. A final chapter deals with the question of future legislation, and from every point of view this book should be in the hands of all those who have to work with these products.

"A MANUAL OF PRACTICAL PHYSICAL CHEMISTRY." By Francis W. Gray. MACMILLAN & Co., LTD., London, 1914. Pages 211 + ix, with Index, Tables, and 61 Illustrations. Price 4/6.

This small work can be thoroughly recommended to those who wish to find a well-arranged and satisfactory text-book for students starting work in physical chemistry. It is certainly one of the best books for this purpose. The illustrations are well chosen and greatly add to the value of the text. It would be difficult to improve on its present form. The author is equally thorough in his suggestion that the one student—one experiment plan of working should be adopted in the laboratory, but in this respect he will no doubt expect to receive criticism from those who advocate measurements made before the whole class, or work done by sets of two or more to each experiment. Possibly, from a practical point of view, a blend of the whole three methods produces satisfactory results. There is a tendency for the student to feel lonely in his work if he always works in the way suggested, but the system involved is undoubtedly a very thorough one when properly carried out.

"PRINCIPLES OF METALLURGY." By Arthur H. Hiorns. Second Edition. Revised and enlarged. MACMILLAN & Co., LTD., London, 1914. Pages 389 + vi, with Index. Chapters XXV., with 144 Illustrations. Price 6/-

The second and revised edition of a useful text-book will be welcomed by students of metallurgy, as it deals chiefly with the practical side of the subject. A satisfactory elementary knowledge of the principal metallurgical operations in use to-day can be obtained from its perusal. If one has any fault to find with this work it is of a secondary nature; the type utilised for the text is rather small for general work. In the same way many of the illustrations have been unnecessarily cramped by being reproduced on too small a scale. But these are only details, the subject-matter itself is excellent.

"COMPLEX IONS IN AQUEOUS SOLUTIONS." By A. Jaques, D.Sc., F.I.C. LONGMANS, GREEN & Co. Pages 152 + vi. 4/6 net.

The aim of this book is to give an account of the experimental data available, which is classified under the respective methods utilised for research purposes, such as the chemical method, the ionic migration method, the solubility method and the electrical potential method, a chapter being devoted to each method. Other chapters are concerned with such special subjects as ammoniacal solutions, those of copper and cobalt, special cases of equilibrium and the hydrate theory. A name and subject-matter index is included. This somewhat involved subject is treated in a concise and satisfactory manner, and the work will serve a very useful purpose as an account of past work achieved in this direction.

"A FOUNDATION COURSE ON CHEMISTRY FOR STUDENTS OF AGRICULTURE AND TECHNOLOGY." By J. W. Dodgson and J. Alan Murray. LONGMANS, GREEN & Co., LTD., London, 1913. Pages 243 + x, including Appendix and Index. Chapters XVI., with Diagrams. Price 3/6 net.

This is a work written for the general student in agriculture. Somehow we doubt its utility if it is to form the basis of the agricultural chemist's knowledge of chemistry. On turning over the pages of the book, one feels that the knowledge obtained from its pages will be superficial. The authors acknowledge that the arrangement of the matter is somewhat unconventional, and this is so.

"UNDERGROUND WATERS FOR COMMERCIAL PURPOSES." By Frank L. Rector. CHAPMAN & HALL, LTD., London, 1913. Pages 98 + iv, with Appendix and Bibliography. Chapters X., with 8 Illustrations. Price 4/6 net.

This work will probably find its chief use as a simple guide to engineers and factory managers concerning the work done by those who have dealt with the question of a suitable water supply.

BOOKS, ETC., RECEIVED.

"An Introduction to the Study of Physical Metallurgy," by W. Rosenhain, F.R.S. Constable & Co., London. Pages 368 + xvi, with 31 Plates and 131 Text Figures. Price 10/6 net.

"The Spectroscopy of the Extreme Ultra-Violet," by Theodore Lyman. Longmans, Green & Co., London. Pages 136 + v, with 14 Illustrations. Price 5/- net.

"A Text-book of Physiological Chemistry," by Olaf Hammarsten and S. G. Hedin. Translated by J. A. Mandel. Seventh Edition. Chapman & Hall, London. Pages 1026 + viii. Price 17/- net.

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, *Chartered Patent Agent,*
Queen Anne's Chambers, Westminster, S.W.

11530/13. FARBENFABRIKEN VORMALS F. BAYER & CO. **Vulcanising Rubber.**

The vulcanisation of rubber, natural or artificial, is accelerated by the addition of small quantities of piperidine or its homologues. In an example, 100 parts of Para rubber or artificial caoutchouc from isoprene are vulcanised for 15 minutes at from 135—145° C. with 10 parts of sulphur and 0.5 part of piperidine.

11542/13. W. FUCHS. **Catalysts.**

Catalysts to be used in the hydrogenation of liquid fatty acids and their glycerides are prepared by heating such base-metal carbonates as can be easily dissociated, for example, nickel carbonate, under the surface of oil to be hydrogenated and treating with reducing gas introduced under pressure. The temperature employed varies between 210—290° C. according to the carbonate chosen. According to an example, finely powdered and preferably freshly prepared nickel carbonate previously dried at a temperature of 110° C. is mixed with castor oil and heated to 230° C., and a stream of highly-compressed hydrogen admitted through a capillary nozzle. Reduction of the carbonate to metal takes place, and when this action is completed, the hydrogenation is proceeded with after the temperature has been lowered.

11653/13. S. CARLSON. **Phosphates, Ethereal ; Ferments.**

Carbohydrate phosphoric esters and salts thereof are obtained from inorganic phosphates and fermentable sugar or materials containing such sugars, such as mash, by means of yeast to which has been added poisons such as toluene, thymol, chloroform, phenol, formaldehyde, sodium fluoride, etc., which weaken or arrest the fermenting power of the yeast, but do not stop the action of the phosphate-synthesizing enzyme phosphates. According to an example, cane sugar solution is mixed with press yeast and toluene, and disodium phosphate solution is added; when the reaction has ceased, the solution is filtered and heated to precipitate albumens and calcium chloride is added to convert the ester into its calcium salt, which is precipitated by alcohol and washed with dilute alcohol. Any free phosphoric acid formed by hydrolysis during the heating to separate albumens can be removed by the addition of ammonia and magnesium and ammonium chlorides.

11741/13. CHEMISCHE WERKE VORM. DR. H. BYK. **Esters.**

Oxyfatty-acid esters are obtained by heating alcohols, or their substitution products, with oxyfatty acid anhydrides, polymerized or not, in the presence of catalysts, or by heating the depolymerised anhydrides with the alcohols, etc., without catalysts; comparatively low temperatures are sufficient. Suitable catalysts are acids, such as hydrochloric acid, or compounds of heavy metals, such as aluminium sulphate, titanous acid, or titanous anhydride. Suitable anhydrides are polylactide, obtained by heating lactic acid in a current of air, or polyglycolide, or the lactide or diglycolide obtained by distilling these bodies. Methyl, ethyl or amyl alcohol, polyvalent alcohols, etc., can be used.

11749/13. CHEMISCHE FABRIK GÜSTROW DR. HILLRINGHAUS AND DR. HEILMANN. **Enamels.**

An opaquing agent for white enamels consists of mixtures of titanous acid and zirconium oxide, or compounds containing zirconium oxide, an example of which is a compound with 85% of zirconium oxide, some alkali, silicic acid and water. The titanous acid may contain alkalies and silicic acid. The composition of the enamel may be as follows: 4½ kilos. zirconium oxide, 1½ kilos. titanous acid, 7 kilos. clay used in enamels, and 100 kilos. of a mixture consisting of 20.5 kilos. borax, 30.4 kilos. feldspar, 19.7 kilos. quartz, 8 kilos. soda, 2.7 kilos. potassium nitrate, and 16 kilos. cryolite.

11758/13. G. H. HULTMAN. **Purifying Gas.**

Sulphur compounds such as carbon disulphide, benzol, and naphthalene are removed from coal gas by washing the gas in alcohol cooled to or below 0° C. Some other washing-liquid may be used, cooled to the same temperature and possessing the same property as alcohol of being able, at the same temperature, to prevent freezing of the moisture separated from the gas on account of the low temperature. At temperatures of from —15° to —20° C. good absorption is obtained, and the gas after being treated may be washed with water to recover the alcohol, the washing-liquids being subjected to fractional distillation to recover the sulphur compounds and alcohol. A suitable washer comprises alternate washing and cooling compartments, the washing liquid passing from one washer to the other and the cooling fluid from one cooler to the other.

11768/13. M. PLANKO. **Leather.**

A process for treating leather, particularly applicable for making driving-belts, consists in splitting hides or skins and assembling the splits together by means of celluloid, which permeates the leather and coats the faces of the sheets so that they may then be united by a celluloid composition. The assembled pieces may be passed between rollers or otherwise pressed.

11809/13. E. HERZ. **Explosives.**

Consists in the use of pentaerythrite tetranitrate in combination with ammonium nitrate, with or without combustibles, aromatic nitrocompounds, and alkaline salts, to form explosives safe against fire-damp. One example contains 73.6% of ammonium nitrate, 12.6% of pentaerythrite tetranitrate, 7.8% of trinitrotoluene, and 4% of potassium nitrate.

11966/13. H. HANEMANN AND F. HANAMAN. **Coating Metals.**

Iron and steel articles are provided with a rust-preventing coating, consisting of a combination of iron with nitrogen, by heating them to a temperature above 400° C. in an atmosphere of dry or moist ammonia, or chemical combinations, organic and inorganic, which, on heating, liberate ammonia or products of decomposition of ammonia. Such bodies are, for example, ammonia salts, hydrazine, and combinations thereof, amines, imides, and other nitrogen compounds. The articles to be treated may have a layer of scale thereon, or may be previously cleaned, and the surface may be smooth or etched.

12233/13. T. O. FRANKE. **Fuel.**

In pressing peat, etc., to obtain fuel, coke dross or other fuel substance impregnated with oil, fat, paraffin, resin, naphthalene, asphalt, etc., to render it non-absorbent, is added. Iron filings, ironstone, sand, ashes, slag, coal, peat, mineral coke, lignite, charcoal, wood, sawdust, chaff,

straw, leather, manganese, salt, limestone, and stones are stated to have been added to materials, such as peat, from which moisture is to be expressed.

12365/13. A. HEINEMANN. **Propylene.**

Propylene is prepared by the interaction of acetylene and methane in the presence of a catalyst consisting of a common metal such as iron, copper, nickel, aluminium, and silver, together with a rare metal such as platinum, palladium, and iridium. The mixture of gases is heated or subjected to the action of actinic rays or silent electric discharges. In preparing the catalyst, a porous body such as pumice stone is coated with copper, for example, by electrolysis or reduction of a copper salt, and the mass is then dipped into a salt of a rare metal such as platinum chloride and dried, and the salt is then reduced. The common metals may also be used finely divided or in strip form, such as copper gauze, copper wool, aluminium turnings, or magnesium strips. These metals are dipped into a solution of a rare metal salt such as a platinum or palladium chloride, and the rare metal deposited by electrolysis.

12366/13. A. HEINEMANN. **Chlorhydrocarbons.**

Glycerine is prepared by treating propylene with chlorine or its equivalent in the presence of actinic rays to produce dichloropropane, then removing one molecular proportion of hydrochloric acid by means of heated metals, alkalis, etc., converting the resulting allylchloride into trichloropropane, and finally heating this compound with water in presence of an alkali or not.

12376/13. C. F. DIPPEL. **Explosives.**

Consists of a mixture of potassium chlorate (2 parts),

sugar (1 part), and denatured alcohol (1 quart to 1 gallon for each 100 lbs. of the powder). The alcohol may be denatured by an addition of petroleum benzene.

12421/13. C. GLADITZ. **Tungsten.**

Tungsten bars suitable for mechanical treatment are compressed from a mixture consisting of the fluffy powder obtained as described in Specification 27859/12 together with from 5% to 25% of a larger crystalline variety. The larger crystals may be obtained by subjecting the fluffy powder to a pressure of 80 kilos. per square mm. in a mould of the kind described in Specification 12244/12, heating the bar or not, and then grinding to powder and separating the larger from the smaller crystals by means of a sieve; or the fine powder may be heated without compression to a temperature of 1,800°—2,000° C. The bars produced are heated electrically in four stages to a temperature of 2,600°—2,700° C., the current being gradually increased by the use of a liquid resistance. The maximum temperature is maintained for five minutes, whereupon the current is gradually reduced to zero.

12626/13. A. HUMANN AND E. TEISLER. **Sodium-aluminium Fluorides.**

Sodium-aluminium fluoride, $2\text{Al}_2\text{F}_6\text{NaF}$, is obtained by reacting on sodium fluosilicate with aluminium oxide or hydrate in the presence of an excess of hot water sufficient to dissolve the liberated silica as a colloidal solution. The double salt, separated from the silica solution, may be converted into cryolite by treatment with sodium fluoride, or may be used as an ingredient of enamels or bone glass.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

Scarcity of Iodine in Holland.

Holland is experiencing an acute scarcity of iodine owing to the fact that several countries have prohibited the exportation of the commodity. This has caused the Government of the Netherlands to direct its attention to new sources of supply, such as the iodine wells in the East Indies. Java possesses wells the waters of which have a magnesium-iodide content equivalent to 30 to 120 mgs. of iodide per litre. The iodide is extracted by precipitation from the slightly acidified solution with copper sulphate, and the cuprous iodide containing from 50 to 55% of iodine which is thus obtained is put on to the market.

According to Dutch official statistics the yield of pure iodine from this source amounted in 1909 to 23,973 kg. The existence of rich iodine wells in Batavia, Samarang, and Timor, Dutch East Indies, has been known for many years, and it is believed that Holland can increase the supply from these sources. It is interesting that iodine wells are frequently near petroleum wells, the petroleum being in the upper and the iodine water in the lower stratum.

Commercial Possibilities of Australia's Gum Trees.

The curator of the Technological Museum of Sydney records that there is an increasing demand for so-called "mineral oil," obtained from the eucalyptus, so named commercially, because it is used in the flotation process of obtaining sulphides from tailings. This special oil yields

as much as 86 to 90% concentrates. There is a considerable supply of the trees from which this oil is obtained, but the consumption is also increasing by leaps and bounds.

A species of eucalyptus yields geraniol, the active principle of attar of roses. At Eltham (Victoria) large plantations are being set up and already leaves have been distilled. There are other products of eucalyptus, namely the two *turpentines* of commerce, called the French and the American turpentine. The product of the two Australian trees, *E. loeropinea* and *E. dextropinea*, could also be utilised in the manufacture of *synthetic camphor* for which turpentine is required. The leaves of a Queensland eucalyptus yield *citral*; from this again artificial perfume of violets is manufactured. *Citronellal* is obtained from lemon-scented gum trees. This by no means exhausts the constituents discovered in eucalyptus oils. Their utilisation and potentialities in many other avenues of industry still remain to be determined.

Production of Alkalies from Rocks containing Alkali.

The Chemische Werke Rhenania, at Aachen, are using a patented process of Dr. A. Messerschmidt, Stolberg (Rhineland), by which it is claimed that the difficulties of separating into its components the mixtures of potassium and sodium compounds have been overcome. It is known that during disintegrating of rocks containing alkalies, especially volcanic rocks, the boiling of the charge with caustic lime produces mixtures of compounds of K. and Na,

which are very difficult to treat. The novel process converts the alkalis directly into nitrates by treating, for instance, phonolite or other similar rocks with a watery solution of calcium nitrate, magnesium nitrate, or another related nitrate, and boiling the charge in alkaline solution. Free caustic lime being usually present in commercial basic calcium nitrate acts advantageously during the reaction. At boiling temperature the reaction takes place slowly, therefore autoclaves and higher temperature, with corresponding pressure, are used.

An ordinary charge consists of 1 ton of phonolite, 0.6 tons of basic calcium nitrate, water at a pressure of from 4 to 10 atmospheres during 10 to 20 hours. The result is a slime which, after being systematically lixiviated with water, gives a solution consisting of almost chemically pure alkali nitrates. A small quantity of calcium as nitrate in excess can be easily precipitated by adding alkali carbonate or hydroxide. The clear solution is now neutralised with nitric acid and inspissated. From 1 ton of phonolite about 180 kg. of potassium nitrate and 220 kg. of sodium nitrate are produced which can be easily separated into pure potassium and sodium compounds.

Prospects for Coal-Tar Production in the United States.

The following references to the American imports of coal tar products, contained in a monograph prepared for the Geological Survey, are of special interest in view of the stoppage of German supplies. The report says :—

It has been contended that the development of the by-product coking industry would have shown more rapid progress if markets for the by-products were assured. This contention pertains principally to the coal tar and its products, as there is practically at all times a fair demand for ammonia. The total value of domestic coal tar produced in 1913 from retort coke ovens was \$2,830,158. No information is available regarding the quantity and value of the products obtained from this tar, as in going to the distillers it becomes mixed with the coal tar from gashouse retorts, and even if the total quantity and value of coal tar products were obtainable it would be practically impossible to differentiate those obtained from retort-oven tar from those obtained from gashouse tar. It is interesting to note, however, that the coal tar products imported into the United States amount to approximately \$10,000,000 annually. In 1913 the total value of coal tar products imported into the United States was \$10,962,828, of which colours and dyes made up nearly 80%. The value of the importations by the time they are in the hands of the consumer is probably between \$18,000,000 and \$20,000,000.

The opinions of American chemists and manufacturers with regard to the establishment of a successful coal tar industry in the United States are much divided. It is agreed, however, that the principal drawback of a discouraging nature is the lack of protection to American industries from the standpoint of tariff, and the privileges given to foreign patentees. Anti-trust laws, moreover, are firmly opposed to certain combinations, which in Germany made it possible to encourage manufacturing by giving the concerns the command of larger capital and enabling them to dispose of by-products at much greater profit than would otherwise be the case.

New Publication devoted to Applied Biology.

Under the editorship of Professor Maxwell Lefroy, at one time Entomologist on the staff of the Imperial Department of Agriculture for the West Indies, and now Professor of Economic Entomology in the Imperial College of Science,

London, the Association of Economic Biologists has recently decided to issue an official organ known as the *Annals of Applied Biology*. In this journal papers dealing with a wide range of subjects connected with economic biology are to be published. In the editorial to the first number it is stated that the Association is endeavouring to form a link between biological workers in Great Britain and in the Colonies, which object is likely to be achieved by this interesting journal.

Potash to be Produced in America.

Secretary Lane recently announced that he had been informed from Searles, Cal., that the first American potash will be produced by the Searles Lake plant within three months. The initial output will only be five tons a day, but the plant under construction is expected to ultimately produce 120 tons. German potash exporters enjoyed an absolute monopoly in the American market, but the check to imports caused by the war showed the American consumers more clearly than ever the advantage of developing a commercial supply within the country. Although the home production to be started at Searles will necessarily be very limited, the news of the projected exploitation of the deposits is nevertheless welcomed as a first step in attacking the German monopoly.

Prospects of a Gelatine Shortage in England.

The leading organ of the British hatting industry, in a recent article, draws the attention of manufacturers to the prospects of a gelatine shortage and consequent enhanced prices. France has been one of the principal purveyors of this article, but her supplies, owing to the withdrawal of so much labour for military purposes, seem likely to be decreased should the war be prolonged for any great length of time. It is, therefore, necessary that British glue makers—and especially the Scotch section of this industry—should try and put on the market a gelatine suitable for the hatting trade in the lower grades, such as has been made in Germany and Austria. There are, it is agreed, serious climatic difficulties, but in these days of artificial means of drying these ought to be overcome. Luton possesses already a large gelatine manufactory, which is, however, mainly used for making kinematic and photographic film kinds, but it has supplied certain makes of gelatine to the local hatting trade with satisfactory results. The point to be studied is this: If gelatine of the high quality and pure colour necessary for photographic, etc., work can be produced in the varying climate and temperature of Bedfordshire, glue-makers in other parts of the kingdom can probably make sufficiently clear, good gelatine, free from frothiness, suitable for hatting purposes.

CONSULAR AND OFFICIAL REPORTS.

Sulphur Dioxide in Austria.

In a report received at Washington from Prague, Bohemia, there is a discussion of the production of sulphur dioxide in Austria. It contains some references to the principal sources of sulphur dioxide, and a presentation of the patented processes, as well as some details of the forms under which it is to be marketed, etc. The report says: "The principal sources of sulphur dioxide, SO₂, are ore roasting or calcination of gases, pure sulphur, pyrites, and sulphide of zinc. It is also produced from used up gas-cleaning materials, from by-products of the Leblanc process, which is now of little importance, and finally from sulphates, particularly hydrated sulphate of lime. The

composition of the gases containing SO_2 differs very much. Those produced directly from sulphur contain 11.23% by volume of SO_2 ; those from pyrites, 8.59%, and those from sulphide of zinc, 8.1%.

The methods of concentrating and liquefying sulphur dioxide are manifold. All of them are akin to the process of Schröder and Hönisch. All aim at absorption through water, after which the solution is heated so that SO_2 is separated; it is then condensed by compression or refrigeration. Such processes and the apparatus employed are described in several German, English and American patents.

Sulphur dioxide is used for a variety of purposes, such as medicinal, metallurgical (*e.g.*, the separation of copper), etc. As a liquid it is used in solutions in the conservation of dried fruits, in the production of wine, for the bleaching of flour and textiles, as a disinfectant, in the manufacture of sugar, glue and gelatine, in the production of sulphite cellulose and in refrigeration.

Canada's Forest Products Laboratories.

The Dominion Forestry Branch has spared no reasonable expense in equipping its Forest Products Laboratories, recently established at Montreal in co-operation with McGill University, with the most modern and efficient machines for testing the properties and possibilities of Canadian woods. An important feature of the work of these laboratories will be to examine chemical methods for utilising the large percentage of wood waste at present resulting from lumbering and milling operations. A circular will soon be issued from the Forestry Branch, Ottawa, dealing with chemical methods of wood utilisation.

Canadian Inquiries for British Manufacturers.

Inquiries have been received at the Canadian Government Offices, 17, Victoria Street, Westminster, S.W., where further information may be obtained concerning them. A Montreal firm of chemical importers having terminated its connections with Germany asks to be placed in immediate communication with United Kingdom manufacturers of Epsom salts, saltpetre, caustic potash, sugar of lead, prussiate of potash, tartaric acid, citric acid, oxalic acid, formaldehyde, hyposulphite of soda, nitrate of lead, prussiate of soda, quinine, cyanide of potassium, etc. A firm of commission merchants of Toronto asks to be placed in touch with United Kingdom manufacturers of chemicals suitable for rubber manufacturers, such as litharge, lithopone, sulphur, barytes, magnesia and pigments. Inquiry is also made from Toronto for names of English manufacturers of cream of tartar, tartaric acid, citric acid, benzoate of soda, casein, etc.

Production of Sulphate of Ammonia in Japan.

According to an American consular report the daily output of sulphate of ammonia in Japan amounts to 58 tons or about 19,080 tons a year. The Mitsui colliery at Omuta has decided to extend its ammonia factory and increase the daily output to 10 tons, and the Imperial Railways also propose to produce about 3 tons of the article upon the completion of the electric generating station at Yaguchi. The Japan Nitrogenous Fertiliser Co. have decided to increase their daily output to 35 tons upon the completion of their generating station at Shirakawa. The annual output of sulphate of ammonia will increase over 20,000 tons by the end of this year. Taking the annual import of the article at 120,000 tons, the increase would therefore represent about 16 to 17% of the whole importation.

Soya Bean Oil.

Since the outbreak of the war several large shipments of soya beans, including 100,000 bags from Vladivostock, have reached this country for the purpose of extracting the oil. Hitherto Germany has imported considerable quantities direct from Manchuria, the Stettiner Oelwerke A. G. of Stettin alone importing about 45,000 metric tons in 1913. H.M. Consul at Stettin states that after many experiments this firm has succeeded by a process of neutralisation, decoloration, etc., in refining the oil to such an extent that it is now largely used in Germany instead of the more expensive cotton seed oil, in the manufacture of margarine and edible fats. In West Germany it is also used as salad oil. Through the success of the above-mentioned method of rendering the oil palatable the firm enjoys the protection of the higher duties imposed on edible oils.

New Cellulose and Paper Mill for Norway.

According to a report of the Belgian Consul in Trondjem, Norway, a syndicate of capitalists has been formed who have subscribed 2,000,000 francs for the construction of paper and cellulose mills in the vicinity of Trondjem, where there are waterfalls furnishing 1,100 h.p. that can be utilised in the new undertaking. The contemplated annual output of the plants is spoken of as 6,000 tons of pulp and 4,000 tons of paper.

MARKET REPORTS.

LONDON.—The exports of chemicals and allied products during September decreased by £390,074 as compared with the same month of last year, the values amounting to £1,235,907, against £1,625,981. Although the total has diminished—a fact which is entirely natural under the circumstances—there has been an increase in the exports of certain items, such as soda compounds, dyestuffs, bleaching powder, etc. With regard to the latter chemicals the opinion among leading firms seems to favour the probability of a considerable expansion of the business in the near future. The recent demand has shown unmistakable signs of growing, and the present high values are likely to be maintained for some time.

The home trade in chemicals is still hampered by the scarcity and extravagantly high prices in some sections of the market, yet the general position compares favourably with that of many other branches of trade. The uncertainty with regard to the future of the cotton industry in Lancashire prevents textile manufacturers from buying chemicals beyond their immediate wants, but in some sections of the engineering industry there are signs of a coming revival which promise well for the consumption of suitable chemicals.

The expectation of an upward movement in values of sulphate of ammonia, which was expressed in our last report, has meanwhile been realised, owing to a better export demand. Buyers of sulphate for immediate delivery have been obliged to pay £11 per ton for good grey 24½% quality, while forward positions realised up to £11 5s. The exports of this fertiliser during September must be called fairly satisfactory, amounting to 25,871 tons, against 28,111 tons in 1913. Of course, it has to be considered that neither Germany nor France imported anything during the month under review. The position of the nitrate of soda market becomes daily more difficult for importers and sellers. The stoppage of consumption on the Continent is causing an

enormous accumulation of stocks in our ports, and the readiness with which Chilean exporters grant price concessions seems to indicate little confidence in the future of the commodity. The present quotation for refined nitrate is 11s. 3d., and for ordinary quality 11s. Tar products are characterised by extreme dulness. Shipments of pitch have been few and far between, and producers are seriously thinking of making combined efforts for improving the position. The price of pitch remains in the neighbourhood of 30s., but is more or less nominal. Benzol is neglected and weak. The business in this article suffers most acutely from lack of shipping possibilities, which cause over-production and large stocks. Ninety per cent. benzol is quoted at 10½d. to 1s. per gallon. Creosote remains firm at 3½d. The inquiry for naphtha from rubber manufacturers has improved in consequence of large army orders. Solvent is quoted at about 1s. per gallon. Naphthalene enjoys a good demand at steady prices. Carbolic acid has remained unaltered at 2s. 3d. for 60% acid, while crystals are held at 8½d. to 8¾d.

MANCHESTER.—The general business in heavy chemicals has been very fair. Caustic soda finds ready buyers at £8 10s. to £10 5s., according to quality. The abnormally high level of values for potash products has not been maintained, although the reduction is not yet very pronounced. Bichromate is obtainable at 7d. The great scarcity of acetate of lead explains the extraordinary high price of the article, viz., 40s. per cwt. for white, and 35s. for brown quality. Cream of tartar develops irregularity.

LIVERPOOL.—The export demand for chemicals is rather better, and fair transactions are taking place in bleaching powder for delivery during 1915. Caustic soda for next year is not quite so steady as a little time ago, and home buyers were able to obtain small concessions. Carbonate of potash has also shown a weaker tendency, as consumers refused to pay the extreme prices demanded; 90% to 92% quality is obtainable at £50 per ton. Very little business is done in tartaric and citric acids, the quotations being 1s. 7d. to 1s. 9d. and 3s. 3d. to 3s. 6d. per lb. respectively.

The chemical industry at Widnes is in a state of great activity, owing to the stoppage of imports from the Continent. Acute shortage of labour has made itself felt, and the manufacturers have great difficulties in coping with the demand.

GLASGOW.—Business in chemicals leaves much to be desired, though in some sections of the market there is fair activity. Bleaching powder has experienced active demand from abroad. Magnesia, zinc salts and aniline colours are in short supply and the inquiry shows signs of increasing.

Metal Markets.

LONDON.—The state of the metal markets has been depressed on account of the insignificant support from speculators and others. Although the copper prices have touched a new low record level, consumers show no eagerness whatever to provide themselves. Electrolytic copper has been freely offered at £53, but buyers were very scarce. The official quotation of best selected copper is fixed at £54 to £54 10s. per ton. Although stocks in producers' hands are not yet very large, they are still accumulating. The world's producers are said to be more inclined to reduce output, but the results of this policy cannot be felt for some time yet. The tin market suffered under heavy selling pressure. The stocks in warehouses have, however, experienced a further reduction, and it is considered pretty certain that con-

sumers do not hold large quantities. The inquiry for tin plates is slack. Straits tin has gone down to £124 10s. cash. The demand for Dutch tin in Holland has diminished, and there is still a large surplus there to draw from. English lead is nominally quoted at £18 10s., and soft foreign at £17. Quicksilver is out of offer and unofficially quoted at £10 to £11.

FOREIGN ITEMS.

The Proctor & Gamble Co., the well-known glycerine refiners of Cincinnati, have decided to make Hamilton, Ontario, their Canadian headquarters. A site has been selected and a soap factory to cost \$100,000 is contemplated. Other factories also are to be built in other Canadian cities.

The exportation of sulphur and flowers of sulphur from Norway has been prohibited.

Dr. Harvey W. Wiley, the former adviser on food products to the Government of the United States, has urged that the war tax be levied upon rectified liquors, so-called soft drinks, containing alkaloids, bleached flour and secret remedies, and that \$100,000,000 might be raised in this way.

Iodine is in such short supply in Austria that the Minister of the Home Department has authorised pharmacists to make tincture of iodine half strength, that is 1 in 20 instead of 1 in 10.

The exportation of medicaments from Switzerland has been prohibited, but exemption can be had in certain cases. Requests should be addressed to the Swiss Ministry of Commerce.

NEW COMPANIES.

CITY OF LONDON EQUIPMENTS, LTD.—Capital, £25,000. Object: To carry on in connection with the business of a general supply society that of wholesale and retail dealers in drugs, chemicals, toilet requisites, etc. Secretary: F. King, Caxton House, Westminster, S.W.

THE BRITISH MILK PRODUCTS Co., LTD.—Capital, £15,000. Object: To carry on the business of manufacturers of food, medicine preparations, drugs, casein, and other products derived from milk and other sources. Registered office: 69, Mark Lane, E.C.

PROVIDENT STORES, LTD.—Capital, £10,000. Object: To acquire and take over as a going concern the business of general dealers, chemists, druggists, etc., now carried on by Sam. Lineham, under the style of "The Provident Stores" at Hemsworth, Crofton, South Elmsall, Goldthorpe, Grimthorpe, Doncaster, etc. Registered office: Portland Place, Doncaster.

A. T. BECKS & Co., LTD.—Capital, £15,000. Object: To acquire the business now carried on at Birmingham under the style of "A. T. Beck's & Co." as manufacturers of, and dealers in, chemical and other preparations, including sal ammoniac, muriatic acid, residual and other products. Governing director: H. J. Fisher.

ELECTRO CHEMICAL COMPANY OF SOUTH AFRICA, LTD.—Capital, £2,000. Registered in Transvaal on March 29th, 1914, to carry on the business indicated by the title. British address: 13, St. Helens Place, E.C.

THE CHEMICAL WORLD

A MONTHLY JOURNAL
OF
CHEMISTRY AND CHEMICAL ENGINEERING

EDITED BY W. P. DREAPER, F.I.C.

"Science moves, but slowly slowly, creeping on from point to point."—TENNYSON.

VOL. III. No. 12.

DECEMBER, 1914.

[ANNUAL SUBSCRIPTION 6s. Post Free.] 6d. net.
" " " " " " " " " " " "

State Aided Industry.

THE action taken by the Board of Trade in connection with the possible formation of a company to undertake the manufacture of dyestuffs in this country is one of considerable importance. The step is obviously taken as a result of a consideration of several factors, notably that the total textile output, as reckoned on the basis of the 1907 Census of Production, has a value of some £333,000,000 per annum, of which amount raw material is reckoned at £235,000,000. Against this the annual production of aniline and other dyes (including the home production) is probably represented by a sum of £2,250,000. The danger of this relatively small section of the industry (as represented on a money basis) threatening to hold up the industry is probably unparalleled in industrial affairs. It indicates a state of unpreparedness which is not altogether a credit to British organisation.

The experiment, when carried out, will be a notable one. It is stated that the total capital involved will be in the neighbourhood of £3,000,000, and that if the trade subscribes this amount in ordinary shares on co-operative lines, the Government would guarantee the interest on a debenture issue of £1,500,000.

Thus, after years of inordinate advertisement on the part of a foreign enterprise, a serious attempt is to be made to secure the production of dyestuffs in this country on an adequate scale. As a mere matter of insurance against possible loss to the textile industry as a whole, the venture is to be recommended, if there is no other means of dealing with the situation as it stands to-day.

Unless the new company is to take over all existing dyestuff works and consolidate them into a working whole, with the necessary staff of experienced chemists, which on anything like the basis adopted abroad may possibly run into hundreds, it may be suggested that an important part of the new company's programme should be to secure an adequate supply of intermediate products for the other works. It is this factor which has apparently prevented a more rapid development of existing works, and has, we believe, influenced the Government in allowing foreign dyestuffs to still enter this country through Holland, where they are to be used for Government orders.

The question of compulsory licences under patent rights will be one of some difficulty, which, however, must be squarely faced, and great attention paid in the future to the fact that it will not be sufficient to merely trade on the research of other countries, but that this branch must be highly organised if the industry is to rest on a secure foundation. Although it is probably a fact that not more than 80% of output is protected by patents, it is unfortunate that the remaining 20% represents very important products.

The organisation of the scientific side of the scheme will undoubtedly present many difficulties, but here no doubt the failures of the past will be traced to their source, and obviated, as far as possible, in the new scheme.

There are other industries which will have to be dealt with in an equally thorough manner, such as that of the manufacture of artificial silk.

SOME INTERESTING PUBLICATIONS OF THE U.S.A. GOVERNMENT—continued.

By A. H. MAUDE, A.I.C.

The paper before us is entitled, "Critical Ranges A_2 and A_3 of Pure Iron," by G. K. Burgess and J. J. Crowe (Bulletin of the Bureau of Standards, Vol. 10, No. 3). The importance of this investigation is made clear in the following extract, giving an account of the state of knowledge of this subject at the commencement of the research:—

"The question of the allotropy of iron, in spite of a vast amount of experimental work and perhaps an even greater amount of theorising, is not yet settled. That there is a definite transformation in iron near 900° , the A_3 point, is generally recognised, as well as the fact that the temperature of this transformation is lowered by the addition of carbon and metallic elements. On heating, the transformation Ac_3 is always at a higher temperature than the transformation Ar_3 on cooling. Whether the A_3 transformation is sharp, like the melting point of a pure substance, or extends over a considerable range of temperatures embracing perhaps as a lower limit the A_2 change, appears to be still an open question for pure iron. The nature and the identity of the A_2 transformation, it would appear from recent publications, has not yet been satisfactorily settled."

The paper gives a critical and historical summary of the experimental work previously done on this subject, and tabulates the temperatures of change of various physical

properties obtained by various workers and different methods. These results, though they vary to an extraordinary extent, generally seem to indicate two changes in iron in the course of heating up to $1,000^{\circ}\text{C}$. Among the properties which have been observed to change at one or both these points are magnetism, crystalline form, thermoelectric effect, rate of cooling, electrical resistance, etc.

The method employed by the authors was the cooling-curve and heating-curve method. The actual curves obtained are reproduced in the bulletin, and they leave no doubt whatever as to the existence of the two transformations, and of the temperature, within a very narrow range, at which they occur.

The first problem to be tackled was that of obtaining pure iron. It was found, for instance, necessary to fuse the iron *in vacuo* in order to free it from occluded gases, which change the effects considerably and probably account, in part, for the divergence between many of the previous determinations.

The authors' method of obtaining the curves was by heating the sample of iron *in vacuo* in a specially constructed electric furnace, its temperature being accurately determined at frequent intervals by thermocouples. Their curves plainly indicate two sharp changes, (evolutions of heat), denominated A_2 and A_3 . The latter is less definite but much more intense than the former and it is important to note (as this accounts very largely for the unsatisfactory results of former determination) that the cusp of the curve is far less definite when a large mass of iron is used. It is, therefore, necessary in order to obtain comparable figures, to extrapolate the results for the position of the cusp of the cooling or heating curve to zero mass and zero rate of cooling (or heating).

A footnote on the theory of the subject gives a very concise account of the problem before the investigator, of which the following is a *résumé*:—

"Some of the experimental facts that any theory must satisfactorily account for are: a definite thermal effect . . . located at $768^{\circ} \pm 0.5 = Ac_2 = Ar_2$, *i.e.*, with no measurable lag; a much greater thermal effect, but dependent upon rate accompanying a marked crystallographic change, and, as extrapolated for zero rate, located at $Ac_2 = 909^{\circ}$ and $Ar_3 = 898^{\circ}$. Both the Ac_2 and Ac_3 maxima appear to be anticipated by gradual changes in physical properties below these temperatures defining the maxima. Finally, A_2 and A_3 are distinct transformations."

"Among the experimental uncertainties are: whether with A_2 there is associated any crystallographic change, however slight—it being recalled that the thermal change is also very slight—and whether there is any volume change accompanying A_2 . Concerning A_3 , we are not sure whether, as zero mass and zero rate are approached, Ac_3 exactly equals Ar_3 or not. For neither A_2 nor A_3 has the beginning of Ac_2 or Ac_3 been exactly located."

Defining an allotropic transformation for this purpose as one accompanied by a crystallographic change, the authors go on to state that "there appears to be no doubt that A_3 is an allotropic transformation under this definition, but sufficient experimental evidence is still wanting to decide in favour of A_2 being an allotropic transformation. . . ."

Reasoning from analogy of quartz, which has two points like A_2 and A_3 , and has definite crystalline changes at both points, "the following hypothesis may be made regarding the nature of the A_2 transformation in iron, namely, that A_2 is an allotropic point accompanied by a very minute but as yet undetected crystallographic change and differing from A_3 mainly in magnitude. . . ." It might be

added that "all physical properties of iron which have been studied, with the single notable exception of crystallographic structure, have shown in the hands of one or more skilful experimenters a distinct discontinuity for the A_2 range as well as for the A_3 range. For several of the phenomena, such as electrical resistance, thermoelectricity, specific heat, and magnetism, it would appear that the discontinuity is at least as great for A_2 as for A_3 , while the thermal effect has, of course, been long recognised as being more pronounced at A_3 ."

EFFECT OF THE WAR ON THE COLOUR USING INDUSTRIES.

THE Council of the Society of Dyers and Colourists appointed some two months ago a committee to consider ways and means of dealing with the shortage of chemicals and dyestuffs caused by the war.

Lord Moulton, a member of the Board of Trade Committee on Chemical Products, and chairman of the special committee appointed by that Board to deal with the question of the supply of chemicals and colours, has had interviews with several members of the local committee, and this committee has now obtained direct representation on the Board of Trade Committee in the person of Dr. Alfred Rée.

Statistics are being collected from the principal colour users with a view to ascertaining the approximate consumption of the chief individual dyestuffs, of which the bulk was formerly obtained from Germany.

The committee is of opinion that every assistance should be given to English makers to enable them to extend their manufacturing operations.

NOTES OF MEETINGS.

Chemical Society.

December 3rd. "A redetermination of the Atomic Weight of Tin," by H. V. A. Briscoe. "Isomerism of the Oximes," Part VI., "*p*-Dimethylaminobenzaldoxime," by O. L. Brady and F. P. Dunn. "Organo-derivatives of Bismuth," Part II., "The Stability of Derivatives of Quinquevalent Bismuth," by F. Challenger and C. D. Allpress.

December 17th. Ordinary Meeting.

Society of Chemical Industry.

LONDON SECTION.—December 7th.

Society of Public Analysts.

December 2nd. "Application of Spectrography to Analysis," by S. Judd Lewis. "Note on some Oleaginous Seeds," by E. R. Bolton and Enid M. Jesson. "Corrections in Bomb Calorimetry," by G. N. Huntly. "Note on the determination of Sulphates in Flour," by G. D. Elsdon.

Biochemical Society.

December 8th. Lister Institute, London, 5.30 p.m.

Society of Arts.

December 2nd. "Britain and Germany in Relation to Chemical Trade," by Dr. W. R. Ormandy.

December 16th. "Testing Pigments for Permanence of Colour," by Sir W. de W. Abney.

December 17th. "Indian Indigo Industry," by Dr. F. M. Perkin.

Institution of Mechanical Engineers.

December 18th. Ordinary Meeting.

Institution of Electrical Engineers.

December 10th.

MANGANESE AS A FERTILISER.

By E. A. FISHER, M.A. (OXON.) (Research Department, South-Eastern Agricultural College, Wye).

THE influence on plant life of those rarer elements which are occasionally found in soils was until comparatively recent years but little studied. This neglect was probably due to the fact that such substances, if present at all in ordinary agricultural soils, are present only in very small amounts and plants grow normally, and seem just as healthy whether grown in a soil containing these rarer elements or in a similar one without them. During the last ten or fifteen years, however, the subject has been brought into prominence both in this country and abroad. Increasing attention has been given to the fertilising action of these rarer elements, and an interesting field of work has been opened up which is being rapidly attacked in different parts of the world by numerous investigators.

Of these so-called *catalytic manures* that have so far been investigated compounds of manganese are the most interesting, and have been most worked at from both the agricultural and bio-chemical points of view.

The first investigator to do any work on this subject was Prince Salm-Horstmar about 1849 (*Journ. prakt., Chem.*, Vols. 46—47 (1849) p. 193). He found manganese in the ash of the oat plant and examined the effect of salts of manganese in pot-cultures of carbon made from cane sugar. In these experiments he found that manganese stimulated plant growth and increased the assimilation of other salts present in the nutrient solution added to the carbon.

Nothing more was done for a good many years until experiments were started at the pot-culture station established at Woburn in 1898, under the auspices of the Royal Agricultural Society. These experiments have been continued every year up to the present and detailed accounts of them are to be found in the Journals of the Royal Agricultural Society from 1900 onwards. The Woburn experiments have been carried out in three different ways :

(1) By soaking the seeds before sowing in solutions of various strengths of different salts, *e.g.*, fluorides, chlorides, bromides, and iodides of sodium, potassium and lithium, and the oxides of titanium and manganese ;

(2) By the use of water-cultures, so as to examine the effects of these substances on the roots of plants ; and

(3) By adding small manurial dressings (up to 5 cwt. per acre), usually in solution, but sometimes in intimate mixture with the soil, to pot-cultures.

In other places many field experiments have also been carried out.

These four methods may therefore be regarded as the four typical methods of investigation of the cultural effects of salts of manganese and other so-called catalytic manures.

A review of the literature shows that almost innumerable experiments have been carried out with manganese compounds in both water-cultures, pot-cultures and in the field. The chief salts employed have been the dioxide, carbonate, iodide, nitrate, chloride and sulphate in quantities varying from 9 lbs. up to nearly $2\frac{1}{2}$ tons per acre, but usually less than 1 cwt. especially of the more soluble salts. The results of these experiments have varied considerably ; in fact in common with all manurial trials, there has been a notable want of concordance between the results obtained by different experimenters, and it has happened not infrequently that the same investigator has failed to obtain the same results on repeating his work. Facts like these can only be explained by the assumption that the action of such fertilisers depends on certain factors not at present understood. In the great majority of cases, however, applications of not more than 50 lbs. of manganese salts to the acre have given increased yields of a variety of different crops on widely different soils. The chief crops experimented with have been rice, peas, beans, tares, oats, wheat, barley, maize, potatoes, sugar-beet, carrots, mustard, cabbage, onions, radishes, apricots, tobacco, flax and grass.

The literature is too voluminous to quote in detail and a few of the more important and typical experiments can alone be mentioned.

At Woburn in 1902 and 1903 (Voelcker, *Journ. Roy. Agric. Soc.*, Vol. 64 (1903), p. 348 ; and Vol. 65 (1904), p. 306), it was found that the iodide (MnI_2) applied at the rate of 1 cwt. per acre was harmful to wheat and barley ; the oxide (Mn_3O_4) on the other hand, at the rate of 2 cwt. per acre, had a beneficial effect on wheat and also, although to a lesser extent, on barley. In 1904, the effects of using the sulphate were investigated and the results were compared with the effects of similar quantities of ferrous sulphate (Voelcker, *Journ. Roy. Agric. Soc.*, Vol. 66 (1905), p. 205). The experiments were carried out in two ways :

(1) The seeds were soaked before sowing in solutions of $MnSO_4$ and $FeSO_4$ of 1%, 2% and 5% strengths ; and (2) solutions of the salts in water were directly applied to the young plants at the rate of $\frac{1}{4}$, $\frac{1}{2}$ and 1 cwt. per acre.

In the first case, *viz.*, that of soaking the seed, the germination in the case of wheat was distinctly improved ; by $MnSO_4$ up to 2% strength, by $FeSO_4$ up to 1% only. Higher concentrations than these diminished the germination. Soaking in $MnSO_4$ caused no increase in yield either of straw or grain ; but soaking in 2% and 5% $FeSO_4$ gave increase in both.

The application of $MnSO_4$ as a manurial dressing up to $\frac{1}{2}$ cwt. per acre improved the yield both of

grain and straw; FeSO_4 did similarly up to 1 cwt. per acre. Similar but less pronounced effects were observed with barley.

O. Loew (*Landw. Jahrb.*, Vol. 32 (1903), p. 437) found that small amounts, *i.e.*, up to 0.02% of MnSO_4 gave an increased yield in the case of several different families of cultivated plants, *e.g.*, barley, wheat, peas, radishes, cabbages, in both water-culture and pot-culture. He noticed that cruciferous plants in particular were more benefited than gramineæ. Loew subsequently went to Japan and continued his investigations there in conjunction with his pupils. Experiments with rice gave not only increased yield of grain, but a bigger ratio of grain to straw. He noticed also (Loew and Sawa, *Bull. Coll. Agric. Tokyo*, 1902-3, 5, 161) that excess of manganese exerted an injurious action which in most cases consisted of a bleaching out of the chlorophyll and that the juices of such bleached plants has a more intense oxidising power than juices from healthy plants.

Aso (*Bull. Coll. Agric. Tokyo*, 1904-5, 6, 131) by using MnCl_2 obtained one third larger yield of rice, and Nagaoka (*Bull. Coll. Agric. Tokyo*, 1902-3, 5, 467; 1904-5, 6, 135) found that not only did MnSO_4 stimulate rice, but that the beneficial effect of manganese was evident in the following year, the yield being 16.9% greater than in a similar soil not fertilised with manganese.

Fukutome (*Bull. Coll. Agric. Tokyo*, 1904-5, 6, 137) found that the joint action of FeSO_4 and MnCl_2 had a marked effect on the growth of flax while each alone had very little effect; while on the other hand Garola (referred to by Rousset, *Ann. Sci. Agron.*, 1909, 2, 81, where all the previous work is reviewed) found that manganese salts alone greatly increased the growth of flax and caused a greater assimilation of nitrates, phosphates, potash, lime, etc.

Bertrand (*Compt. Rend.*, 1905, 141, 1255) repeated some of the earlier experiments and extended them. Thus he grew oats in plots on a soil already containing manganese to the extent of 0.057%. Two plots were selected and received the usual fertilisers, but to one of them MnSO_4 was added at the rate of 50 kilos. per hectare (= about 45 lbs. per acre). This plot gave an increase of 22.5% in the total crop over the plot receiving no manganese. This increase was made up of 26% on the straw and 17.4% on the grain. Bertrand made analyses of the oat grain and these showed that the grain from the Mn-plot contained less moisture, and slightly less nitrogen than that from the other plot and it also had a higher bushel-weight.

Katayama (*Bull. Coll. Agric. Tokyo*, 1906, 7, 91) showed the stimulating effect of manganese salts on barley, rice, oats, peas, etc., and showed that the effect was greater on leguminous crops than on non-leguminous ones. Thus using MnSO_4 on peas in pots to the extent of 0.015% he obtained 50% increase in the yield of seeds; whereas with barley the total increase was only 10%. He found that quantities much larger than the above tended to decrease the yield. Another interesting observa-

tion was made by Sjollesma and Hudig (*Verlag Landbouwk Onderzoek Kijksland — bouwproefstat.*, Netherlands, 1909, 5, 29; also *Expt. Sta. Record*, 1909, 21, 115) in Holland, who found that oat-sick soils could be restored to health by the application of MnSO_4 .

Many experiments seem to show therefore that manganese salts in small quantities do exercise a useful stimulating action on plant growth. Excess of manganese on the other hand may prove injurious. This was noticed, as has been pointed out above, by Loew and by Katayama. Salomone, too (*Le Staz. Sper. Agric. Ital.*, 1905, 38, 1015, and 1907, 40, 97), with wheat showed the beneficial action of moderate quantities of manganese salts and the injurious action of larger quantities. He points out that manganic salts are more toxic than the manganous ones, manganic acid being especially so.

More exact work was done by Miss Brenchley at Rothamsted (*Annals of Botany*, Vol. 24, 1910, p. 571) in examining the effect of MnSO_4 on the growth of barley in water-cultures. In moderate concentration, *i.e.*, more than one part of Mn in 10,000 of water, there was retardation of growth; at lower concentrations, such as one in 100,000 and upwards there was distinct evidence of stimulus. Incidentally it was noticed that at such concentrations as one in 10,000 the manganese taken up by the plant was excreted as peroxide on the surface of the leaf.

We may notice that manganese is found widely distributed in many, if not in most, agricultural soils, although usually in small quantities. Le Clerc in 1872 (*Compt. Rend.*, 75, 1209) by a delicate calorimetric method found manganese in most of the soils and vegetables examined by him; and of 26 American soils recently analysed the amount, expressed as MnO , varied from 0.01 to 0.51%. The average content was about 0.071% or about 2,800 lbs. per acre-foot. This amount compares not very unfavourably with the phosphate content of soils although the quantity of the latter assimilated by the plant is very much greater than is the case with manganese. The frequent lack of concordance between the results of different investigators (*cf.* Fukutome and Garola above) are probably due to a number of factors, among them being differences in the amount and nature (*i.e.*, whether MnO_2 or undecomposed silicates) of the manganese originally present in the soils used. In this connection it is interesting that in several soils the natural manganese content is so high that it has been found injurious to the crops grown. The most striking cases of this are certain of the Hawaiian pine-apple soils (Kelley, *Journ. Ind. and Eng. Chem.*, 1909, 1, 533) and the failure of grass on many soils in New South Wales (Guthrie and Cohen *Agric. Gazette of N.S.W.*, 1910, 21, 219).

Some other factors that cause such anomalous results in the use of manganese salts in the hands of different investigators are the mode of application of the fertiliser, the form of the manganese added, the character of the soil, the nature of the crop and the nature of the associated organic matter. Re-

peated application of small amounts in the form of top dressings seem more favourable than a single application of the same total amount of manganese salts at the time of manuring before the seed is sown. The stimulating action seems to be greatest on humus soils, least on sandy soils, while effects of intermediate magnitude are produced on clay soils. It is significant too that in Katayama's experiments the soil used had received no fertilisers for five years and was in a very worn-out condition. Many other investigations seem to indicate that manganese salts are most effective on naturally poor soils or on those that have got into very poor condition, and are least effective on rich productive soils and especially acid ones or those in need of liming. The nature of the crop grown is an important factor, some crops being much less affected than others. Thus Kelley found that pineapples were seriously injured by excess of manganese in the soil. Maize, pea-nuts, beans, cow peas and a number of other legumes were also more or less seriously injured although to a less extent than pineapples. Sugar cane suffered still less injury, while cotton and certain weeds were quite unaffected.

In summarising this part of the subject we may say that the results of experiments have varied considerably, but in the great majority of cases applications of not more than 50 lbs. per acre of manganese salts have given increased yields of a large variety of crops on widely different soils. The action on rice and leguminous crops seems to be more favourable than on non-leguminous ones; and it affects cruciferous plants more than it does gramineae.

In many cases the increase in yield has been very considerable, upwards of 25% and 30%. In a considerable number of instances no increase has been obtained; probably in these cases other factors were involved which would render the manganese ineffective.

Large applications of manganese salts, *e.g.*, more than 1 cwt. per acre, have in general been found injurious. Of the various compounds of manganese the dioxide seems to be the least effective, perhaps because the metal is already present in the soil in this or some similar form. The sulphate has received most attention and has given the best results. Least work has been done with the chloride, but in common with the sulphate in small quantities, it has produced increased yields. In larger quantities both sulphate and chloride have been found to be more toxic than either the dioxide or the carbonate.

The question arises, What is the nature of the stimulus exerted? In particular, Is it on the plant, or on the soil, or on both? This point is both interesting and important. It is undoubtedly true that increased growth has been observed to follow the application of certain manganese salts to the soil; but the soil is extraordinarily complex in constitution and its equilibrium is very easily disturbed as has been very strikingly shown by the recent work on the partial sterilisation of soils by heat and by antiseptics. Hence it is by no

means safe to conclude that any increased growth following the application of a manganese salt is due to the stimulating action of the salt in question directly on the plant. So involved are the actions taking place in the soil, the resultant only of which is represented in the growth of the plant, that we have no right to draw any conclusions from such experiments regarding the direct action on the plant of the material under consideration. That is, neither plot nor pot experiments can tell us anything about the mechanism of the action.

The *direct* action of manganese salts on plant growth can be studied by means of water-cultures; but in this case we must notice that the results are not always the same as in pot-cultures (*e.g.*, in the former plants are sensitive to much smaller amounts of material than in the latter), and may be quite different (*cf.* action of copper salts which have been found always toxic in water cultures but may be quite innocuous in the soil).

We may say then, that since beneficial, as well as toxic, effects are found in water-cultures it is probable that the effects in this case are directly on the plant. In the soil both effects possibly occur: the direct action on the plant, and the indirect one due to a disturbance in the chain of equilibria in the soil.

Of the many effects that may possibly be brought about by salts of manganese, one calls for special attention. Spontaneous oxidation is of more vital importance in the plant economy than has been generally supposed, and is of very general, indeed of practically universal, occurrence. It occurs in all parts of the plant and in all parts of the soil and is affected very considerably by many catalytic manures, but especially by salts of manganese and iron. As mentioned above Loew and his pupils found that the juices of plants bleached by the application of excess of manganese salts possessed greater oxidising power than those not so bleached. This increased oxidising power may be due to the assimilation of some manganese salt, the plant thereby acquiring increased vigour.

These considerations are strengthened by work of another kind; work that again shows us the vital importance of oxidation in the plant economy. A Japanese worker Yoshida (*J.C.S.*, Vol. 43 (1883), p. 472) isolated from the juice of the lac tree—*Rhus vernicifera*—an oxidising principal which he considered to be an enzyme and called *laccase*. Bertrand (*Compte. Rend.*, Vol. 118 (1894), p. 1215; Vol. 122 (1896), p. 1132; Vol. 124 (1897), p. 1032) found that this laccase contained manganese; in fact that half its ash consisted of manganese and that this metal played an important part in the oxidising action of laccase since the oxidising power was increased by adding traces of some manganese compound. No other metal was found to act in this way (and he tried iron, aluminium, copper, zinc, calcium, magnesium and potassium). Bertrand, later, found similar oxidising enzymes in many other plants—in particular in perennial rye grass, lucerne, turnips and horse radish—and since then they have been found very widely distributed in a very large number of

plants and fruits and are known collectively as oxidases. In many cases their action is increased by adding a little manganese or iron salt, and one or other of these two metals is practically always found in the ash of these enzymes. Bertrand found that the oxidase in lucerne is much feeble in oxidising power than laccase and is also poorer in manganese. The admixture of a trace of manganese with it, however, greatly increases its oxidising power. Again Vadam (*Journ. Pharm.*, Vol. 9 (1899), p. 515) found no manganese in the oxidase of hellebore but did find iron.

Similar oxidations brought about by small quantities of iron or manganese salts are well known in the laboratory. Thus iron tannate and hydrogen peroxide will oxidise many substances such as phenol and tyrosine, which are resistant to oxidases. A solution of ferric chloride (3 parts of Fe per million of water) will oxidise aloin, whereas ferrous sulphate will not, even when present to the extent of 25 parts of Fe per million, unless H_2O_2 is present; in which case one part of iron per million can be detected by this reaction. Also ferrous sulphate and H_2O_2 will oxidise hydrogen iodide with liberation of iodine.

Plant roots have a very strong oxidising action as can be readily seen by the red oxidation product formed by the action of wheat seedlings on a dilute solution of aloin. This fact is very significant, for it has been shown that this power of oxidation is closely connected with the metabolic activity of the roots. Schreiner and Reed (*Bul.* 56, *Bureau of Soils, U.S. Dept. Agric.*) have shown that oxidation by roots grown in extracts from productive soils was greater than that brought about by plants grown in extracts of unproductive soils; from which it would appear that from a soil-fertility point of view oxidation by roots has considerable interest. It has been shown, too, that whatever increases the development of the plant increases oxidation by the roots; and whatever decreases the oxidation by the roots decreases the growth of the plant. For whatever increases the oxidising power of roots enables the plant to partially eliminate the ill effects of injurious substances. Thus the harmfulness of dihydroxystearic acid among other things is overcome by such fertilisers as nitrates and others which tend to increase oxidation by roots (*Bul.* 70, *Bureau of Soils, U.S. Dept. Agric.*, 1910). Harmful organic substances under proper conditions seem to suffer change in the soil. This change may occur under conditions of thorough aeration and oxidation, which are promoted by thorough tillage and good drainage and also by the addition of substances which increase oxidation in the soil. This would seem to be a function of manganese. Its addition to soils of low fertility increases the oxidation and by so doing may change the organic material present and make it a better medium for plant growth. This point has recently been tested in America by Skinner and Sullivan (*Bul.* 42, *U.S. Dept. Agric.*, 1914). They added salts of manganese to extracts of soils of low fertility in which wheat seedlings were growing and found that

both oxidation by the roots and the growth of the plants were increased. In the case of extracts of productive soils oxidation was likewise increased, but the growth was diminished. The effect of excessive oxidation was noticeable; the leaves were yellow at the tips and appeared bleached. The natural processes of oxidation in the productive soils were good and the addition of manganese caused excessive oxidation and thus injured the culture as a medium for growth.

Roots have also a certain amount of reducing power (as instanced by their power of reducing sodium selenite and tellurite), although this is almost entirely intracellular; and it is interesting that this oxidation and reduction vary inversely with each other as the plant develops. Thus oxidation is feeble in the young seedling but increases as the seedling grows. On the other hand reduction predominates in the early stages of the seedling's growth, but becomes less and less as the seedling develops and oxidation becomes predominant.

The soil itself possesses oxidising power, and the oxidation in this case appears to be mainly non-enzymatic, the result of interaction between inorganic constituents and certain types of organic matter. Thus it is increased by the addition of various metallic salts, those of manganese or iron being the most effective, especially in the presence of suitable organic matter such as the simple hydroxy-acids, citric, tartaric, malic, glycolic and their salts.

The action of manganese as a fertiliser may, in part at least, be attributed to its direct action on the plant, by increasing the oxidation in the roots, thereby stimulating the plant to greater activity; and to its indirect action. The latter would consist of its power of rendering injurious organic material in the soil harmless, or even beneficial (cf. the action of manganese on oat-sick soils mentioned above); and, by the oxidation of inert, or rather stable, organic matter it might cause the nitrogen and other substances contained in it to become more rapidly available to plants. This is significant in view of the fact that recent American work (see *U.S. Dept. of Agric. Bureau of Soils Buls.* 36, 40, 47, 53, 70, 74, 83 and 88) seems to indicate that the nature of the organic matter of the soil is a factor, and in some cases may be a limiting factor, in soil fertility; so that it is not unlikely that the beneficial results of liming and fallowing, as also of the application of manganese salts, are partly to be found in the changes of organic matter in the soil brought about either by oxidation or by the direct action of micro-organisms.

Bacterial Treatment of Peat.—The Board of Agriculture has made a grant of £150 towards the cost of further experiments in this direction to Prof. W. B. Bottomley, of King's College, London, it being agreed that reasonable facilities are to be accorded to accredited scientific workers who may desire to undertake investigations with "bacterised" peat, which is claimed to have fertilising properties.

THE RISE AND PROGRESS OF ELECTRO-CHEMISTRY.

By ARTHUR J. HALE, B.Sc., A.I.C.

THE earliest recorded observations in electro-chemistry are those of Henry Cavendish and Joseph Priestley. In the year 1779 Priestley noticed that an acid substance was produced when moist air was acted upon by electric sparks, and two years later he observed that when hydrogen and oxygen were mixed together and "sparked," the side of the containing vessel became dimmed with moisture.

Cavendish correctly interpreted these observations, and stated that, in the first case, nitric acid was formed, while, in the second case, water was the product. These discoveries were closely followed by Van Marum's comments concerning the pungent odour observed when an electrical machine was being used, an odour which Schönbein (1840) ascribed to a new substance called by him ozone.

The invention of Volta's cell in 1800 led to the development of the electric battery, which provided a steady flow of energy suitable for electrolysis, and in the same year water was electrolysed by Nicholson and Carlyle, who also electrolysed various salt solutions and observed that the solution round the electrodes often became acid or alkaline.

This work was continued by Cruikshank, who, in 1801, recorded his observations upon the electro-deposition of metals and suggested that lead, silver and copper might be estimated by electrolysis.

Sir Humphrey Davy, in 1807, isolated sodium and potassium by electrolysing the fused hydroxides, and this discovery was followed by the separation of magnesium and barium by the same means.

A knowledge of the quantitative relation between the various factors in electro-chemistry was necessary before any great advance was possible, and this knowledge was established chiefly by the work of Ampère (1775—1836), Coulomb (1736—1806) and Faraday.

The two former workers defined the connection between current strength, quantity, and electromotive force; and upon the foundation thus laid, Faraday was able to establish the beginnings of an exact electro-chemistry. By 1834 Faraday's laws were published, viz., the quantity of an electrolyte decomposed, is proportional to the quantity of electricity passing through it, and, secondly, when the same current passes through several electrolytes, the quantities of the substances liberated at each electrode are proportional to their chemical equivalents.

Joule's law was established in 1840, which expressed the relation between heat developed in a circuit, current strength, resistance and time ($H = Cr^2t$). Upon the laws of Joule and Faraday depend the measurements and calculations of modern electro-chemistry and electro-metallurgy.

In 1851 a patent was granted to Charles Watt

for preparing caustic soda and chlorine by the electrolysis of sodium chloride solution; the scheme included the production of hypochlorite and chlorate, but it remained undeveloped for nearly forty years.

Aluminium was obtained by R. Bunsen (1854) by the electrolysis of the fused chloride, while W. von Siemens devised a tube suitable for producing ozone in 1858, and, shortly afterwards (1860), Andrews and Tait demonstrated that ozone was a modified form of oxygen.

The discovery of calcium carbide was recorded by Wöhler (1862), who had repeated the experiments of Davy upon the action of the electric current on fused hydroxides, and extended the work.

In 1869, the first electrolytic copper refinery was erected by Elkington, in South Wales, and during the period 1870—72 Gramme's improvements in dynamo design rendered great service to the progress of applied electro-chemistry.

Apart from those discoveries just outlined, the progress between 1860 and 1880 was mainly connected with electro-analysis, although the arts of electroplating and electrotyping developed considerably during that time. The advent of the dynamo in 1867 made large-scale work possible, but it was not until the 'eighties that efforts were made to manufacture substances by electrical means, and the electric furnace had not progressed beyond the experimental stage until after 1880.

In electro-analysis C. Luckow (1860) published results which showed that the quantitative deposition of metals, such as copper, zinc and nickel, was possible; he also separated different metals from the same solution and deposited lead and manganese as peroxides on the anode.

The detection of arsenic electrolytically was utilised in 1860, and Wolcott Gibbs, in 1864, published some results of estimating metals, and suggested the use of a mercury cathode. Another paper from Luckow, in 1875, embodied important results in electro-analysis and general electro-chemistry.

In 1881 Classen published his first paper on the subject, and the electro-chemical school under his direction at Aachen has advanced electro-analysis vigorously. By 1883 the mercury cathode was being used, and this improvement increased the number of metals which could be estimated, because those metals ordinarily attacked by water were found to be free from such action when forming part of a cathode amalgam.

The quantitative separation of metals from one solution by altering the potential used, was well established in 1893; and in 1901 the advantages of rotating electrodes were recognised. It was found that current density and potential could both be

increased when the solution was thus agitated, without any ill effect on the nature of the deposited metal, while the time of an analysis was reduced from about three hours to between fifteen and thirty minutes.

At the present time this method of analysis is being more and more appreciated as a rapid and accurate means for estimating metals, and numerous authentic methods are available for the estimation of acid radicles.

Electrodes where the rotating cathode is a cylinder of platinum gauze which is surrounded by a stationary platinum anode are in general use.

Industrial electro-chemistry made considerable progress during the decade 1880—1890, and the use of the electric furnace, as well as the electrolysis of fused salts and aqueous solutions, developed together. By 1880 the value of electrolytic copper refining was well established, and the first American refinery was started in that year.

The first attempt in the electrolytic winning of metals was made in 1885, at Stolberg, where the Marchese process for copper was tried, and, shortly afterwards, the Siemens and Halske process.

In 1886 C. M. Hall (U.S.A.) patented a process for the electrolysis of alumina in fused fluorides. Further improvements were patented by C. S. Bradley, and, in France, by Héroult. Works were first started in America (1888), and in the following year the process was run by the Pittsburgh Reduction Co.; this start was followed by factories in various parts of Europe, and aluminium, which sold at £120 per kilo. in 1885, was selling at 1s. 4d. per kilo. in 1910.

In 1887 Moissan isolated fluorine by the electrolysis of acid potassium fluoride.

The year 1888 was marked by great activity in the application of electricity to the alkali industry, and during the years 1890—93 patents were taken out by Castner and Kellner for the electrolysis of salt solutions and fused caustic soda, processes which were rapidly developed at the alkali works at Weston Point.

The Acheson Graphite Co. was formed at Niagara in 1889, and, besides graphite, many highly valued abrasives and refractory materials have been discovered in that home of the electric furnace.

Progress in electro-chemistry after 1890 may be more profitably considered if we trace the growth of separate branches.

Electrolytic Winning and Refining of Metals.—Although the first attempts to obtain copper from its ores or from copper-matte by electrolysis were made in 1885, no method has met with any great success, and the winning of metals by this means has made only moderate progress. The methods tried in the case of copper are briefly as follows: The Marchese process, in which a copper-matte anode is suspended in dilute sulphuric acid; copper and iron dissolve from the anode and the former metal is deposited on a pure copper cathode.

This process worked well on a small scale, and copper of 99.92% purity was obtained; but when large quantities were used the voltage rose rapidly

after a short run, and disintegration of the anode led to short circuiting. In the Siemens and Halske method insoluble anodes are used in a bath of copper and iron sulphates, and the cathode compartment is separated from the anode compartment by a diaphragm; this process also was rejected on account of the breaking up of the carbon anodes and the tearing of the diaphragm.

A later process is that of Hoepfner, in which the ore is dissolved in the anode compartment by cupric chloride, $\text{Cu}_2\text{S} + 2\text{CuCl}_2 = 2\text{Cu}_2\text{Cl}_2 + \text{S}$, the cuprous chloride, kept in solution by means of brine, then circulates to the cathode compartment, where it loses part of its copper. Here, again, the main difficulty has been with the diaphragm, but there is reason for believing that the winning of copper will be successful when the mechanical difficulties have been surmounted.

Zinc is in a more promising position. The ordinary distillation method involves a loss of metal and the heat efficiency of the process is low; there is, therefore, room for improvement, and since the conditions under which a good coherent deposit of metal can be obtained by electrolysis are now known, the process is working successfully at several centres. The ore is roasted and the solution obtained by dissolving it in sulphuric or hydrochloric acid is electrolysed. In this country a solution of zinc chloride is used by Brunner, Mond & Co., who obtain it by heating zinc carbonate with chloride of lime under pressure, $\text{ZnCO}_3 + \text{CaCl}_2 = \text{CaCO}_3 + \text{ZnCl}_2$; the calcium chloride is obtained from ammonia-soda waste liquor, and the chlorine evolved is used for making bleaching powder. Attempts to use fused zinc chloride have been handicapped by the difficulty of dehydrating the salt.

Lead has been obtained by using a bath of dilute sulphuric acid and an anode of galena, while antimony is obtained by electrolysing a solution of stibnite in sodium sulphide.

The electrolytic refining of metals is on a much sounder basis, and is to-day applied to the purification of copper, silver, gold, nickel, lead and zinc. In this method the crude metal is made the anode and the electrolyte varies according to requirement; copper and silver have long been refined in this way, but the refining of gold is more recent.

Nickel was first refined at New Jersey, in 1894, the method is now generally used and a cathode of 99.5% purity is obtained.

Lead refining has for its object, besides the preparation of pure lead, the separation of antimony, copper, gold, silver and bismuth. A bath of lead acetate and sodium acetate was at one time used, but that recommended by A. G. Betts (U.S.A.) appears to be better, and consists of a solution of lead fluosilicate containing a small quantity of gelatine.

Electrolytic refining of zinc is usually confined to cases where the metal contains considerable silver, since crude zinc does not contain any metals worth recovering from the anode sludge.

Electrolysis of Water and Aqueous Solutions.—The production of hydrogen and oxygen by the electrolysis of water has received much attention since 1900. The various forms of apparatus patented show that the main problem has been the effective separation of the two gases by means of suitable diaphragms. Metal diaphragms were acted upon inductively by the electrode, became bi-polar, and made a complete separation of hydrogen and oxygen impossible until Garuti found that, if the E.M.F. was below 3 volts and the current density less than 2 amperes, a metal diaphragm remained passive under these conditions. In the apparatus of Garuti and Pompili a 25% potash solution is used, and the iron electrodes are separated by thin iron sheets which are carried well below the bottom of the electrodes and perforated by numerous minute holes to allow of liquid circulation without permitting any gas diffusion.

In another form of apparatus (Schmidt's) the iron electrodes are separated by asbestos sheets bound with rubber edges. The purity of electrolytic oxygen is about 97%, and the hydrogen is usually 99%. Any admixture which takes place in the cells is discounted by allowing each gas to pass over heated platinum on its way to the receiver.

The electrolysis of alkali chloride solutions with the production of caustic soda, chlorine, hypochlorite, chlorate and perchlorate, is a most important electro-chemical industry which has progressed since 1893 largely by the labours of Castner and Kellner.

A thorough understanding of the various conditions which determine the products when sodium chloride solution is electrolysed, is largely due to Foerster and Muller (1900—1905). The requirements for a good hypochlorite yield are concentrated chloride solution, low temperature, platinised anodes, and a small amount of chromate in solution to prevent the cathodic reduction of the hypochlorite formed. If the solution be acidified from time to time, the hypochlorite is converted to chlorate, and a high yield of the latter thus obtained without any additional expenditure of energy. Perchlorate formation from chlorate is apparently due to the liberation of chlorate ions on the anode and their reaction with water, $2\text{ClO}_3 + \text{H}_2\text{O} = \text{HClO}_4 + \text{HClO}_2 + \text{O}$; the oxygen then converts the chlorous acid to chloric, $\text{HClO}_2 + \text{O} = \text{HClO}_3$.

No diaphragm is needed in these preparations, but for the production of caustic soda the anode and cathode compartments must be separated to prevent the chlorine acting upon the caustic.

The first hypochlorite cell used was that of Hermite (1887), and this was followed by those of Kellner and Schuckert. The first chlorate cell was patented in 1884; in the early cells anode and cathode compartments were separated, but since 1897 the use of chromate in the electrolyte has made the diaphragm unnecessary.

The oxidation of chromium sulphate to chromic acid was patented in 1898, and is used in conjunction with the production of anthraquinone from anthracene, when chromic acid is used as the oxidant.

In 1894 Luckow's process was patented for producing insoluble salts and oxides by electrolysis with attackable anodes. The principle was applied to the making of white lead, which is formed if a solution of sodium carbonate is electrolysed with a lead anode; the white lead, however, adheres to the anode, and after a short time no further action takes place. Luckow introduced a secondary salt (sodium chlorate) which was present in much greater quantity than the principal salt (Na_2CO_3), and the anions of which, being greater in number, would keep the carbonate ions away from the anode to some extent and cause the precipitate to form, not on the anode itself, but a short distance from it. This principle is used for making chromate of lead and lead peroxide.

Bromine is prepared on the Continent by the electrolysis of Stassfurth mother liquors rich in magnesium bromide, and bromates are produced in this way also.

Potassium ferricyanide is now almost exclusively prepared by the electrolytic oxidation of ferrocyanide solution, $2\text{K}_4\text{FeCy}_6 + 2\text{H}_2\text{O} = 2\text{K}_3\text{FeCy}_6 + 2\text{KOH} + \text{H}_2$, and the production of permanganate has been improved by electrolytically oxidising the extracted "melt" of manganate, between iron or nickel electrodes, $2\text{K}_2\text{MnO}_4 + 2\text{H}_2\text{O} = 2\text{KMnO}_4 + 2\text{KOH} + \text{H}_2$; here no MnO_2 is formed and the potash is used again for fusion. The economy is evident if the above reaction is compared with that which takes place by the older method, $3\text{K}_2\text{MnO}_4 + 2\text{CO}_2 = 2\text{K}_2\text{CO}_3 + 2\text{KMnO}_4 + \text{MnO}_2$.

Hydrogen peroxide is now being made by the electrolysis of sulphuric acid under conditions which convert it to persulphuric acid; the resulting solution is then distilled under reduced pressure and the hydrogen peroxide, formed by hydrolysis, passes over.

Recent work by Jellinek makes possible the manufacture of hyposulphite by reduction of sulphite, an electrolytic process which has received much attention during recent years.

The Silent Discharge.—This form of energy has apparently been utilised for the production of ammonia by the direct combination of nitrogen and hydrogen; its most important use, however, is for the formation of ozone, which has been largely in demand since 1900 for sterilising water, bleaching, and for oxidising organic substances.

Ozone is now widely used for water sterilisation; in Paris the process of Tyndall and de Vrse is used, in Germany, that of Siemens and Halske, and in Philadelphia the water supply has been greatly improved by the use of ozone produced by the Vosmaer installation.

Application to Organic Chemistry.—Prior to 1890 a great deal of experimental work had shown the value of electrolysis when applied to the preparation of organic compounds, and since then the method has been utilised industrially in several directions. As early as 1884 a patent was taken out for making iodoform by electrolysing aqueous potassium iodide in the presence of alcohol, and the substance is

now made entirely by this method, as also is bromoform by means of potassium bromide and acetone.

Chloral was first prepared in 1894, by dropping alcohol into aqueous potassium chloride during electrolysis, and during 1896-99 patents were granted for the reduction of nitro-compounds and for preparing isopropyl alcohol from acetone. About this time, the electrolytic regeneration of chromic acid, for anthraquinone manufacture, was followed by a process for oxidising anthracene in an anode compartment with 20% sulphuric acid containing 2% of ceric sulphate.

In 1900 Elbs prepared 80% formaldehyde by the electrolysis of sulphuric acid in the presence of methyl alcohol, and in the same year electrolytic reduction was first applied to the purification of crude sugar liquors, while in the next year the oxidation of nitro-toluene to nitro-benzoic acid, and of aniline to quinone, was accomplished, as also the reduction of nitro-benzene and nitro-toluene to benzidine and tolidine respectively. Vanillin is now made by the electrolytic oxidation of isoeugenol, and processes have been devised for oxidising *p*-nitro-toluene to nitro-benzyl alcohol and *o*-toluene sulphonamide to saccharin.

Numerous patents have been granted for the reduction of aromatic nitro-compounds to azo-, azoxy-, hydrazo-, nitroso-, and hydroxylamine-compounds.

The method is well suited to the graded oxidation

of side chains in aromatic compounds, the methyl group, for example, being oxidised to $-\text{CH}_2\text{OH}$, $-\text{CHO}$, or $-\text{COOH}$, as desired; in this case, as with oxidation, the electrolytic process is more easily controlled than that in which the ordinary oxidants or reducers are used.

Electro-chemistry is, therefore, not only of scientific interest, but of great practical importance, and provision is made in most technical colleges to-day for giving the chemical student a short course of instruction in the subject. At some places large and well-equipped electro-chemical laboratories are established, but in any case it is usual to find at least one switch-board and bench, providing accommodation for several students, where small-scale preparations and electro-analytical work can be practised.

The bench, switch-board and fittings are of convenient arrangement; the one in use at Finsbury Technical College is designed for four working places.

It is obvious that electro-chemical industries have flourished for some time in districts where water power is available, namely, Niagara, Norway, the French Alps, and the Pyrenees, and, in this country, further progress is likely since the establishment of large power centres, such as the Newcastle Electric Supply Co. and the Yorkshire Electric Power Co., from which electrical power can be obtained at rates which compare favourably with those at Niagara.

CATALYSIS AND ITS INDUSTRIAL APPLICATIONS.

By E. JOBLING, A.R.C.Sc., B.Sc., F.C.S.

CHAPTER VIII. (contd.).

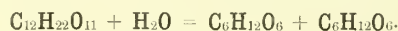
(b) *Hydrolysis of Carbohydrates and Glucosides.*—

All di- and poly-saccharides can be hydrolysed in the presence of dilute mineral acids as catalysts, with the formation of mono-saccharides. Thus—

sucrose + water = dextrose + fructose

lactose + water = dextrose + galactose,

both of which can be expressed by the equation—



The hydrolysis of sucrose or cane sugar is another of the best known examples of catalysis, for its course can be followed by the change in optical rotatory power. It is on account of the change in sign of the optical rotatory power that the reaction is commonly referred to as the "inversion" of cane sugar. The process is of importance industrially, for invert sugar is employed as a permissible addition in the manufacture of wine. It might be noticed that in obtaining cane sugar, the presence of invert sugar may prove undesirable, so that it is necessary to take care that no inversion takes place by the carbonic or sulphurous acid used for saturation.

Starch is an example of a poly-saccharide which

undergoes hydrolysis by mineral acids, in this case with the final production of dextrose (glucose)—



This reaction forms the basis of certain methods for the manufacture of glucose. Potato or maize starch is stirred up with water and the mixture run into boiling dilute sulphuric acid. When the hydrolysis is complete, the product is run into other tanks, the acid is then neutralised with chalk, and the clear solution containing the glucose evaporated under reduced pressure. The use of sulphuric acid is attended by certain disadvantages, but though other acids, such as hydrochloric, oxalic and of late hydrofluoric acids, have been tried, it still remains the usual agent.

The hydrolysis of glucosides can be fairly easily effected by the use of acids, though much less readily—as will be seen in the next chapter—than when the appropriate enzyme is employed.

(c) *Hydrolysis of Proteins and Polypeptides.*—Hydrolysis of proteins by acids has been employed by E. Fischer with conspicuous success in his attempts to determine the constitution of those very complex bodies and as a means to their quantitative estima-

tion. The use of strong acid in hot solution leads to the degradation of the protein into amino-acids, but with dilute acids or alkalies at lower temperatures, two or more amino-acids remain linked together and the result of the hydrolysis is a mixture of proteoses, peptides and peptones. Enzymes are also useful hydrolytic agents.

Conversely, acids are employed in the synthesis of amino acids and their linking up to form polypeptides.

SAPONIFICATION.

As previously mentioned, the term "saponification" is usually confined to the hydrolysis of fats by water, generally with the aid of certain catalysts. Since fats are made up of the glyceryl esters of certain fatty acids, particularly palmitic, stearic and oleic acids, it follows that the reaction results in the formation of glycerol and the liberation of these fatty acids.

It must be realised at this stage that the reaction can proceed in the absence of the saponifying agent. Superheated steam has already been described as effective, but the temperature then becomes so high as to produce discoloration. For reasonable temperatures, the assistance of a saponifying agent must be called in, such an agent functioning in every respect as a catalyst.

The following reactions are carried out on a tremendous scale in the preparation of soaps and fatty acids.

(a) *Saponification by Bases.*—Lime may be employed in an open vat, but the amount necessary is so large—and consequently also the amount of sulphuric acid required to neutralise it—that the costliness of the process precludes its extensive employment.

The proportion of lime can be reduced by utilising the beneficial influence of pressure. If, for instance, the fat be heated with lime in an autoclave under 12 atmospheres pressure, practically complete hydrolysis is effected by the use of 1% lime, instead of the theoretical 10%. At this pressure, nevertheless, considerable discoloration of the fatty acids is developed, so that still lower pressures become necessary. In candle works, where some discoloration is of little account, the autoclaves are worked at 8 atmospheres and 3% lime for 8–10 hours. In the case of soap making, modern practice necessitates reduction to 5 or 6 atmospheres pressure.

In place of lime, magnesia and zinc oxide may be employed. Though these are not such efficient catalysts, and are besides more costly than lime, they possess the advantage of yielding no precipitate on decomposition of the autoclaved material with sulphuric acid.

Again, caustic alkalies prove efficient catalysts. In their case, an excess of the quantity required for complete neutralisation of the resulting fatty acids is employed, for the obvious reason that the resulting salts are the constituents of soaps. There is no doubt, notwithstanding, that by the aid of pressure, complete hydrolysis could be effected by the use

of only a small percentage of the quantity. The alkali—with which the fat is boiled in open vessels—acts primarily as a catalyst and only secondarily as a combining agent for the fatty acids produced. Soda with semi-or non-drying oils produces "soft" soaps; potash with drying oils gives "hard" soaps.

Ammonia, too, has been suggested as a catalyst for the hydrolysis of oils and fats, but as its use requires the aid of pressure, no practical outcome has yet been effected.

(b) *Saponification by Acids.*—The usual acid employed is concentrated sulphuric acid. The fat, which has previously been freed from moisture by heating to 120° C. or so, is rapidly stirred for a short time in a special mixing machine with 4–6% sulphuric acid of 66° Bé. The completeness of the hydrolysis depends upon the strength of the acid; whilst if the temperature rises at all above that found most suitable, secondary reactions, involving the production of sulphur dioxide and sulphonated compounds, are liable to occur. Indeed, for the success of the technical operation, great attention must be paid to the amount of acid, the temperature and the time of contact.

Of greater value than sulphuric acid for the promotion of this reaction is the sulpho-aromatic compound discovered by Twitchell (1900). The preparation of this catalyst is a secret, but it involves the reaction of an excess of sulphuric acid with a solution of oleic acid in some aromatic hydrocarbon, probably naphthalene. The fatty material, after having first been freed from all impurities by boiling with dilute sulphuric acid, is treated for some time with about 2% of the above reagent and half its weight of water in wooden vessels, the mixture being heated by steam coils and kept in agitation. The emulsion is then broken down by the addition of sulphuric acid, and after standing, the upper layer of fatty acid is drawn off.

Other compounds, analogous with Twitchell's reagent, have been patented.

SUBSTITUTION.

(a) *Friedel-Craft Reaction.*—The well-known use of aluminium trichloride for bringing about the substitution of the hydrogen of the benzene nucleus by alkyl groups was first made known by Friedel and Craft in 1877. Since that time, its application has been extended to the introduction into the aromatic nucleus of other groups, e.g., the preparation of aromatic ketones by the use of acid chlorides, of acids by carbonyl chloride, of aldehydes by a mixture of carbon monoxide and hydrochloric acid. Indeed, the reaction now possesses an extraordinarily varied application in organic synthesis.

In all of the above cases, the function of the aluminium trichloride appears to be catalytic. The accepted explanation of its action is based on the formation of complex intermediate compounds, some of which have actually been isolated. Anhydrous ferric chloride brings about the same kind of substitution.

(b) *Sandmeyer-Gattermann Reaction.*—The use of copper salts (Sandmeyer, 1884) or of copper itself

(Gattermann, 1890) as catalysts for the replacement of the diazo group of aromatic compounds by chlorine, bromine, nitrile, nitro and thiocyanate groups is so well known as to need no further description.

It is worth noticing, nevertheless, that Erdmann has shown that when using Gattermann's method, a maximum yield can be obtained if the temperature of the copper salt solution, to which the diazonium salt is added, is maintained at a definite optimum temperature.

(c) *Grignard Reaction*.—In the formation of an addition product of magnesium with the halide in this reaction, anhydrous ether is supposed to play the part of a catalyst. It is certainly not essential to the reaction, for the latter may take place, though less readily and smoothly, in its absence. Ether may be replaced by a tertiary amine, such as dimethylaniline.

A trace of iodine, too, accelerates the formation of the Grignard reagent.

(d) *Halogen Carriers*.—The presence of iodine or of certain metallic halides is found greatly to assist the process of halogenation. All of the metals, whose halides are efficacious, are found to be of dual valency, so that no doubt exists as to their mode of action. In chlorination, *e.g.*, the chlorides of antimony, iron, aluminium, molybdenum and thallium prove effective carriers, as well as the elements phosphorus, sulphur, tellurium and iodine. For the introduction of bromine, the above chlorides or the corresponding bromides are employed.

One of the most important technical examples of the use of a carrier is to be found in the preparation of carbon tetrachloride, destined by reason of its non-inflammability to replace petroleum spirit, ether, etc., as solvents. The method of preparation consists in the chlorination of carbon disulphide. At the ordinary temperature, chlorine and carbon disulphide react but slightly, but in the presence of iodine or antimony pentachloride, rapid formation of the tetrachloride ensues.

ISOMERISATION.

Changes in the structure of a molecule are frequently effected by the action of heat, and as the influence of a catalyst is towards the reduction of the temperature, catalysts find application in this field.

In the industrial production of vanillin, for instance, potash is employed to transform into eugenol the isoeugenol obtained during the process. Many other transformations can be effected, such as the passage of maleic into fumaric acid by the aid of hydrochloric acid, or of aldoximes by sulphuric acid into amides, but they are of interest mainly to the theoretical chemist.

CONDENSATION.

The line of demarcation between condensation and substitution reactions, or even between these and the wider type of dehydration reaction, is very difficult to define. Under this heading, however, are usually included such reactions as involve the

union of two or more dissimilar molecules with or without the elimination of component elements. In the former case, reagents are generally employed which assist the removal of these elements, but do not function catalytically. However, this is not always the case, as is shown by the Friedel-Craft reaction, which might be considered as a condensation reaction.

When no elimination takes place, the presence of a third body, acting in a catalytic manner, is usually necessary for carrying out the reaction.

Thus, the hydroxide of sodium, barium or ammonium, is employed for the condensation of *o*-nitrobenzaldehyde and acetone, which forms one of the steps of the indigo synthesis. Ionone, used as a substitute for essence of violets, is prepared from citral and acetone, using dilute sulphuric acid as a condensing medium. Aluminium trichloride is of service in the preparation of several vat dyestuffs, such as violanthrone, by this process. Small quantities of benzoic or acetic acids act catalytically in the preparation of aniline blue.

Potassium cyanide is the active agent of the benzoic condensation of aromatic aldehydes. For the preparation of the leuco-base of malachite green from benzaldehyde and dimethyl aniline, acid potassium sulphate is added. Copper powder is employed in Ullmann's method of condensation, a process of technical importance in the dye industry. And so examples might be multiplied. Reference to another is found under the next heading. The above, however, are sufficient to indicate the diversity and extent of the application of catalysts in this field.

POLYMERISATION.

Engler has shown that it is possible to produce thick viscous oils by the polymerisation of amylene in the cold with aluminium trichloride—an observation which may have practical significance. Many oils, too, such as linseed oil, tung oil and castor oil, can be "polymerised" by the aid of suitable reagents, but the chemical changes undergone are not yet fully understood.

Metallic sodium has recently received industrial application as a polymerising agent in the transformation of isoprene into artificial rubber, a change which is effected merely by long contact with this agent. Other hydrocarbons are capable of polymerisation by the use of certain catalysts.

Among aldehydes, the well-known tendency to polymerisation is assisted by the presence of small quantities of bases, mineral acids and certain metallic chlorides, leading to the formation either of aldols or polyaldehydes.

As a last example, it will be sufficient to mention the formation of what are known as "phenol-formaldehyde" compounds. These are resinous amorphous products, which, after suitable treatment, are being utilised in rapidly increasing quantities for industrial purposes, mainly as substitutes for ebonite, celluloid, etc.

They are prepared by the condensation and subsequent polymerisation of formaldehyde and phenolic

bodies in the presence of a suitable catalyst. The reaction may proceed in the absence of a catalyst, but only under such unfavourable conditions—high temperature and long contact—as render the reaction impracticable for commercial purposes. The addition of acids or acid salts greatly accelerates the process, but unfortunately their use leads to the development of undesirable by-products.

Bases, on the other hand, serve as excellent catalysts both at the condensation and polymerisation stages and enable the reaction to proceed regularly and to be kept under control. Bakelite, *e.g.*, is obtained by the action of an alkaline condensing agent upon equal quantities of phenol and formaldehyde, the product being heated above 100° C. under a pressure of 50—100 lbs. per sq. in.

DECOMPOSITION.

The classical instances of catalytic decomposition are to be found in the influence of manganese dioxide upon the production of oxygen from heated potassium chlorate, and of finely-divided platinum upon the decomposition of hydrogen peroxide.

In the latter case, it should be remembered that any finely-divided material has a similar effect, so that the introduction of dust into the peroxide bleaching vats should be avoided. Hypochlorite solutions are decomposed in the presence of a small quantity of cobalt oxide.

The catalytic decomposition of hydrogen peroxide has been utilised by Ostwald in a process, known as the Catatype process, for the copying of photographs. The glass negative is rinsed with an ethereal solution of peroxide and allowed to evaporate for a definite short period. During the evaporation, the hydrogen peroxide is fully decomposed in places where the silver occurs most abundantly on the negative, *i.e.*, in the high lights, is not decomposed at all in the shadows, and but partially in the intermediate shades. The invisible positive of peroxide which has thus appeared on the photographic negative is fixed by being pressed upon a gelatine non-sensitised paper and then rendered visible by treatment with ferrous salts.

The preservative influence of certain substances has already been mentioned in Chapter I., as an instance of negative catalysis. Other examples than those given occur in the case of hydrogen peroxide solution which is preserved by a trace of acid, chloroform solution in which oxidation is prevented by a trace of alcohol, and hydrocyanic acid solution which is stabilised by traces of hydrochloric or sulphuric acids.

Conversely, a substance commonly regarded as unstable may owe its instability to the presence of some impurity whose removal would lead to beneficial results. Hypochlorite solution is a case in point. Its ready decomposition was found to be due to the presence of iron in the liquid as ferrate, and after means had been devised for the removal of this, the liquor became a regular article of commerce.

In a few cases, a substance spontaneously develops its own decomposition catalyst. Thus, the

nitro-celluloses used as explosives beget acid compounds which accelerate decomposition. Counter-acting substances, such as diphenylamine in this case, are added to fix the undesirable body.

SOLUTION.

The ability of certain bodies to assist the solution of others is a matter of everyday application in Practical Chemistry. Platinic chloride hastens the dissolution of most pure metals. Zinc will only dissolve in acids when some "impurity" is added. The purer it is, the less the chemical action, from which it is inferred that chemically pure zinc is insoluble in pure dilute acid.

Nitric acid, too, when pure will only slowly dissolve such metals as silver, copper, bismuth, cadmium and mercury in the pure state. As it is the normal development of nitrous vapours which hastens the reaction, the presence of an oxidising body to destroy the catalyst prevents the dissolution.

The solution of certain compounds, too, is hastened by the presence of traces of other material, each compound having its own dissolution catalyst.

CRYSTALLISATION.

The action of crystal nuclei in determining the crystallisation of supersaturated solution and super-cooled liquids is essentially a catalytic—perhaps a special kind of autocatalytic—process. The subject possesses technical importance in connection with devitrification. Closely allied to this is the catalytic influence of certain metals upon the changes of state in the cooling of cast iron. Further consideration of these subjects, however, cannot be attempted here, as opening impracticably large fields of discussion.

PERSONAL AND OTHER NOTES.

THE following awards have been made by the President and Council of the Royal Society :—The Copley Medal to Sir Joseph Thomson, for his discoveries in physical science ; the Rumford Medal to Lord Rayleigh, for his numerous researches in optics ; the Davy Medal to Professor William Jackson Pope, for his researches on stereo-chemistry and on the relations between crystalline form and chemical constitution ; the Darwin Medal to Professor Edward B. Poulton, for his researches in heredity ; and the Hughes Medal to Professor John S. Townsend, F.R.S., for his researches on the electric behaviour of gases.

L. J. Goldsworthy has been appointed Professor of Chemistry at the Victoria College of Science, Nagpur.

John E. Bucher, Associate Professor of Chemistry at Brown University, has been promoted to be head of the chemistry department, thus filling the vacancy caused by the retirement of Professor John H. Appleton. Dr. Harold Bigelow, of Mount Alliston University, has been added to the faculty as Assistant Professor of Chemistry.

The monument which is to be dedicated in memory of Pierre Berthelot, the great French chemist, and be placed in front of the College de France, Paris, has been completed by the artist Paul de Saint Marceaux.

SURFACE TENSION AND SURFACE ENERGY AND THEIR INFLUENCE ON CHEMICAL PHENOMENA.

By R. S. WILLOWS, M.A., D.Sc., and E. HATSCHEK.

CHAPTER XI.

BRIEF reference has been made at the end of the preceding chapter to S. W. J. Smith's experiments, and the evidence obtained by him, showing that the iso-electric point does not necessarily coincide with the condition of maximum interfacial tension, must now be examined. This result is of particular interest in view of the importance assigned to the iso-electric point in the theory of coagulation of suspensions, which has already been pointed out.

If solutions of two electrolytes are brought into contact there is, generally speaking, a potential difference between them, just as there is one at the interface mercury-electrolyte in the capillary electrometer. This potential difference has been shown by Nernst to depend on the difference in the concentrations and the velocities of the ions. Smith uses dilute solutions containing equivalent amounts of KI and KCl; the kation is thus the same in both solutions, and the velocities of the I and Cl ions are nearly equal, so that, according to Nernst's theory, there should be no potential difference or double layer at the interface. These two solutions were employed in the following three experiments:—

(1) Surface tension-potential difference curves for each electrolyte against mercury are plotted in the capillary electrometer, the result being shown in Fig. 16. At P there is, according to Helmholtz, no potential difference between Hg — KCl, and at R none between Hg — KI. If the effects at the interface were purely electrostatic, *i.e.*, dependent only on the lines of force, and if the anions had no specific influence, then QS should be zero. Actually, however, it represents a potential difference of 0.2 volt.

(2) The potential difference between Hg — $\frac{n}{10}$ KCl,

and also that between Hg — $\frac{n}{10}$ KI is measured by the capillary electrometer or by a dropping electrode (these correspond to OQ, OS in Fig. 16). A cell is now made up consisting of Hg — $\frac{n}{10}$ KCl $\frac{n}{10}$ KI — Hg, as shown in Fig. 17, platinum wires being fused in to make contacts with the mercury. The E.M.F. of such a cell, according to Nernst's theory mentioned above, is the algebraic sum of the potential differences across the double layers occurring at the surfaces of contact between different substances. This E.M.F. can readily be measured by the usual electrical methods. As regards the various potential differences of which it is the algebraic sum, those between the platinum electrodes and the mercury cancel each other, since they are equal and opposed; that at the interface KCl — KI is zero, as explained under (1); hence the E.M.F. should be the algebraic

sum of, or difference between, the potential differences arising at the interfaces Hg — KCl and Hg — KI. If the anion had no specific influence, this should be zero: actually it is about 0.2 volt, in agreement with the results obtained above. This shows clearly that the potential difference at an interface mercury-electrolyte depends, not only on the lines of force, but also on the chemical nature of the ions forming the double layer.

(3) In order to produce the maximum interfacial tension in a capillary electrometer, it is generally necessary to apply a polarising E.M.F. Palmer and Smith have, however, made solutions for which the maximum tension occurs when the applied E.M.F. is zero, in which case the points P and R of the curve shown in Fig. 16 fall on the axis OV. Such solutions are called "null solutions," and, according

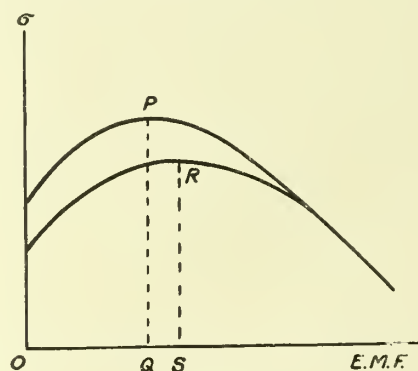


FIG. 16.

to Helmholtz's theory, must be taken to possess the property that there is no double layer and no potential difference between mercury and such a null solution. Smith replaces the decinormal KCl

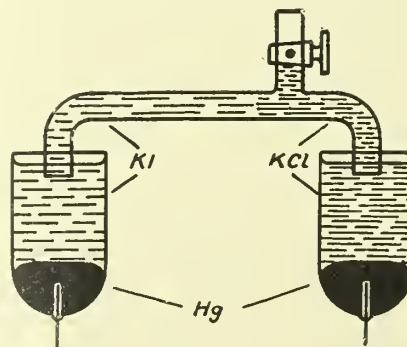


FIG. 17.

and KI solutions in the cell of Fig. 17 by two different null solutions so chosen that there is no potential difference at their interface. The E.M.F. of such a cell should then be zero; it is found, how-

ever, that this is not the case and that the anion again has a specific effect on the mercury surface.

As a result of these experiments Smith concludes that (a) the simple Helmholtz theory of the double layer is insufficient to account for all the observed facts. The potential difference mercury-electrolyte is not purely electrostatic, but depends on the nature of the ions, as, according to Nernst's theory, it should do. This theory, it will be remembered, involves the "solution pressure" of the ions, which varies with their chemical nature. (b) The potential difference mercury-electrolyte is not necessarily zero when the interfacial tension is a maximum, although in the particular case of dilute KCl this condition is very nearly fulfilled.

CHAPTER XII.

IN our discussion of the Gibbs-Thomson formula, it was pointed out that the presence of an electric charge on the particles of adsorbed substance might considerably affect the amount adsorbed. We now proceed to give some attention to this point, in the light of what has been established in the preceding chapter concerning the interaction between surface tension and electric charges. To take a simple case, we will examine what may be expected to occur, according to Nernst's solution pressure theory, when drops of mercury are allowed to fall through a solution of Hg_2SO_4 . The solution pressure, P , of mercury is very small and is lower than the osmotic pressure, p , of the mercurous ions in solution. Hence these ions will be deposited on the mercury surface and will by their positive charge attract SO_4 ions, thus forming a double layer. Hg_2SO_4 will accordingly be abstracted from the upper layers of the solution and will be carried downward by the drops, to be set free again when they coalesce—with consequent decrease of surface—at the bottom of the vessel. This change in concentration has actually been observed by Palmaer, and was, in fact, what enabled him to discover when his solutions were "null solutions." No change would occur if the solution pressure and the osmotic pressure were equal, or if a null solution were used. But this is just what would be expected if the whole phenomenon were due to adsorption in the strict sense of the term, *i.e.*, to changes in surface concentration caused by a decrease of surface energy, as in the experiments of Lewis and of Donnan and Barker. These, however, deal practically with non-electrolytes, and, in deriving a formula applicable to the new conditions, account must be taken of the electrical energy of the adsorbed ions. Lewis has carried out the calculation necessary to show how this affects the amount adsorbed. If V is the potential difference across the double layer at the interface $\text{Hg} - \text{Hg}_2\text{SO}_4$, and a and b the electrochemical equivalents of the negative and positive ions respectively, *i.e.*, the mass of each deposited when unit quantity of electricity is passed through a solution of the electrolyte, the Gibbs-Thomson formula becomes:—

$$U = u_{\text{salt}} + u_+ + u_- = - \frac{c}{R\theta} \left[\frac{d\sigma}{dc} + (a+b) \frac{d\sigma}{dV} \right].$$

a and b are known from electrochemical data, while $\frac{d\sigma}{dV}$ can be found from the $\sigma - \text{E.M.F.}$ curve given by the capillary electrometer, hence the amount adsorbed of each ion can be calculated. In this way Lewis finds:—

$$u_{\text{salt}} = 2.7 \times 10 \times 10^{-7} \text{ gms./cm.}$$

$$u_+ + u_- = 3 \times 10^{-8} \text{ gms./cm.}$$

It will be noted that there should be no ionic adsorption when the interfacial tension is a maximum, as at that point a small alteration in V produces no change in σ , *i.e.*, $\frac{d\sigma}{dV} = 0$. The second term in brackets, therefore, becomes $= 0$, and the formula the original Gibbs-Thomson equation.

The question arises whether this absence of ionic adsorption at the point at which the ions do not affect the interfacial tension does not afford the true explanation of the phenomenon; that is, whether the effect is due to a lowering of interfacial tension, as in the case of non-electrolytes, rather than to the joint action of osmotic and solution pressures. Nernst's theory, although accounting for observed facts, postulates a force—solution pressure—concerning whose origin little, if anything, is known. On the other hand, we are quite ignorant of the effect of ions on surface or interfacial tension, nor does it seem possible to devise any experimental methods for measuring such an effect. Lewis has calculated from Nernst's theory the mass of ions adsorbed, and finds the sum $u_+ + u_- = 1.4 \times 10^{-7}$ gms./cm. The order is not very different from that of the figure obtained above from the modified Gibbs-Thomson formula, but some of the numerical data on which Lewis's calculation is based are open to question.

CHAPTER XIII.

WHAT has been developed in the two preceding chapters as to the nature and probable origin of the double layer has a most important bearing on colloidal chemistry. As is well known, the electrical behaviour of at least one class of colloids, the suspensoids, is among their most characteristic properties, but the origin of the electric charge on colloidal particles is, of course, as uncertain as that of the double layer in the capillary electrometer. Opinion now generally inclines to the view that it is not electrostatic, but due to adsorbed ions; that the latter have specific differences appears strikingly in the cognate phenomenon of electrolyte coagulation, where, *e.g.*, the hydrogen ion in the majority of cases has a much greater effect than the equivalent amounts of monovalent metallic ions. In interpreting these complicated phenomena we are confronted with the difficulty mentioned at the conclusion of the preceding chapter—our ignorance of the laws governing the adsorption of ions—and the general difficulty of all adsorption phenomena on solid surfaces. The latter are supposed to be due to reduced surface energy, but we have no means of measuring surface tensions solid-liquid, and can,

therefore, only assume that their behaviour for a given solution is parallel to that of liquid-liquid or liquid-gas surfaces, an assumption inherently incapable of proof.

It would therefore be of obvious importance to study the electrical behaviour of a surface liquid-air, since in that case we can determine changes in surface tension directly. Such experiments were already carried out by Quincke, who examined under the microscope the travel of a small air bubble in capillary filled with liquid, in an electric field. The method is therefore substantially cataphoresis, but has the drawback that there is only a minute thickness of liquid between the air surface and the glass wall, and that the portion of liquid film adjacent to the latter also travels in the electric field. Quincke found that air bubbles in water were negatively charged—as is the majority of solids—but that they showed no charge in turpentine. This would point to the ionic origin of the charge, since the latter liquid forms no ions.

An entirely different method for investigating the double layer at a liquid-gas surface is that used by Lenard, Sir J. J. Thomson and others, and known as "waterfall electrification." Drops of liquid are allowed to fall through the gas and impinge on an obstacle; in falling they acquire a double layer, which is supposed to be mechanically separated by the shock of impact, so that the signs of the charges on the liquid and on the gas can be determined. Air in this case becomes—as in Quincke's experiment—negatively charged, the air being, of course, positive. In hydrogen, however, the charges were reversed. Dissolved salts also reversed the charges on water, some dyestuffs in particular showing this effect in extremely minute concentrations. Thus Rohde found that a concentration of 0.1 mg. of fuchsin per litre was sufficient to render the water positive.

It is, however, by no means certain that the results obtained by this method are comparable with those obtained by cataphoresis, or, in other words, that the origin of the double layer is the same in both cases. Thus, in experiments according to Quincke's method made by one of the authors, fuchsin did not reverse the charge on the air bubble even in concentrations a thousand times greater than those found effective by Rohde. Similarly discordant and very important results are obtained by McTaggart, who investigates the cataphoresis of a gas bubble by an improved method. The bubble is placed in the axis of a wide rotating tube filled with liquid and is therefore as freely movable as the particles in the U-tube employed for examining colloidal solutions. He finds that air bubbles are negatively charged in distilled water and travel with a velocity, independent of their size within limits, of about 4×10^{-1} cms. per second in a field of 1 volt/cm. This is in very good agreement with the behaviour of colloidal particles in the same conditions. On the other hand, he finds that in this arrangement hydrogen bubbles are, like air, negatively charged, whereas in waterfall experiments this gas is positive against water. The effect

of various cations was found to be similar to that on colloidal particles, ions of high valency having a much greater effect in neutralising and eventually reversing the charge on the bubble, while exhibiting—as in their action on sols—specific peculiarities.

In a further series of experiments McTaggart investigated the electric state of the air bubble in mixtures of water and of several alcohols, and the results obtained are of particular interest, as showing a definite connection between surface tension and electric charge. In the pure alcohols no cataphoresis could be observed. In mixtures of the alcohols and water the velocity of the bubble decreased with increasing alcohol content, and this decrease in velocity—and therefore in electric charge—was the greater the more the alcohol lowered the surface tension of water. The electric charge was therefore reduced by increased adsorption of alcohol at the surface air-solution, and it is reasonable to assume that, with an increased ratio of alcohol in the surface layer, ions would be displaced out of that layer, with a corresponding decrease in the total charge. A further very striking fact was observed: if the size of an air bubble in the water-alcohol mixture was gradually reduced, the velocity, and therefore the charge, increased, approximating more and more to that in pure water. To explain this it is necessary to assume that with decreasing diameter and the consequent change in surface tension the adsorption of alcohol decreases, or, in other words, the percentage of water in the surface layer, and with it that of ions increases. This would be analogous to the change in vapour pressure with the curvature of the surface, which has been fully discussed in a previous chapter.

On the whole McTaggart's experiments, as far as they are at present capable of interpretation, strongly support the view that the double layer is largely or entirely due to the ordinary adsorption of ions.

THE FARADAY SOCIETY.

ONCE more this society is to be congratulated on arranging a general discussion of more than ordinary interest, dealing with the hardening of metals. The programme as announced included an introductory address by Sir Robert Hadfield, and the following items which may be specially mentioned:—

Dr. G. T. Beilby, "Some Recent Papers on Hardening and Overstrain in Metals and the Bearing on these of the Author's Amorphous Theory of the Hardened State"; Professor Ernst Cohen (Utrecht), "The Influence of Allotropy on the Metastability of Metals and its Bearing on Chemistry, Physics, and Technics"; Professor C. A. Edwards, "The Hardening of Metals by Quenching"; Andrew McCance, "The Interstrain Theory of Hardening"; J. C. W. Humfrey, "The Part played by the Amorphous Phase in the Hardening of Steels"; Dr. C. H. Desch, (a) "The Hardness of Solid Solutions," (b) "A Note on Twinning and the Martensitic Structure"; Dr. T. Martin Lowry and R. G. Parker, Note on "Metallic Filings." Professor H. M. Howe and A. G. Levy communicated a Paper on "The Hardening of Manganese Steel." H. L. Heathcote demonstrated the use of instruments for testing hardness.

PATENT RECORD.

Abstracts of recent Specifications specially compiled by
MR. JOHN E. RAWORTH, Chartered Patent Agent,
Queen Anne's Chambers, Westminster, S.W.

13018/13. J. T. JOHNSON. **Cement.**

Relates to the inventions described in Specifications 26528/08, 22810/10, and 23537/11, and consists in using in the manufacture of tile kerbs, hearths, ash-guards, etc., described therein a known cement consisting of sodium silicate with asbestos or zinc oxide, or with both. Alternatively with, or in addition to, the asbestos or zinc oxide, other materials, such as sand, powdered glass, flint, or China clay may be added. Suitable proportions are two parts of sodium silicate to one part of powdered asbestos or zinc oxide. The cement may be made to set by heating to 200—300° F. The provisional specification also describes the addition of calcium chloride to the mixture, and the application of the cement for fixing tiles for any purpose to metal, wood, slate, asbestos or other plates, for example, for making, in addition to the articles above described, panels for grates and stoves, grate interiors, wall panels, table tops, and furniture backs.

13544/13. A. PIETZSCH AND G. ADOLPH. **Hydrogen Peroxide.**

Steam is oxidised to hydrogen peroxide by passage over or through a mixture of persulphate of potassium and sulphuric acid. The mixture is not heated from any other external source.

13657/13. J. P. A. MCCOY. **Resinous Compounds.**

Phenols are condensed with disulphurdichloride in the presence or absence of a solvent, and the product is treated with formaldehyde. The parent materials may be allowed to interact in varying orders, and sulphurchloride-oil compounds may replace disulphurdichloride. The product may be rendered insoluble by continued heating of the initially plastic resinous substance. To the plastic mass may be added, before heating, solvents, such as camphor or glycerine, to render it permanently plastic, and nitrocellulose or rubber may be added as fillers. Other fillers, such as asbestos, silica, wood flour, mica, etc., may also be employed. The mass being hardened by subsequent heating the product has electric insulating properties.

13696/13. B. I. LEVIN. **Treating Flour, etc.**

Flour or stock is treated with an electrolysed solution of ingredients it is desired to add to the flour, such as phosphoric acid, acid phosphates, chlorates, for instance, of potassium, or ammonium salts. Acid or normal potassium sulphate may be added to phosphoric acid before electrolysis, and a platinum anode and lead cathode are employed. The treatment reduces acidity, concentrates the liquid, prevents tendency to recrystallise, and converts phosphates to a form approximating to the organic form. According to the provisional specification, neutral or alkaline phosphates and suitable sulphates, such as those of potassium or ammonium, may be employed.

13753/13. J. L. FRENAY. **Bleaching Processes, etc.**

Straw plait, vegetable fibres, hats, etc., are prepared for bleaching by immersion in a soaking bath containing an alkali pyrophosphate, and subsequently clearing as usual.

In an example, the bath contains a hydrosulphite compound such as Blankit, and is rendered strongly alkaline with sodium pyrophosphate. An example of a clearing bath is a dilute solution of sulphuric acid.

13922/13. M. DEMONGEOT. **Glass Manufacture.**

In the manufacture of glass articles by melting powdered glass in a mould, pressure is applied to the mass during fusion. For this purpose, a weighted die may be employed. In this process, less fusible glass and moulds containing less or no lime may be employed. A suitable composition for the mould material is stated to be potters' clay, kaolin, and flint in equal parts, and for the glass 62 parts of sand, 20 parts of lime, and 18 parts of sodium sulphate. A pressure of 30 to 40 gms. per square centimetre is suggested as a suitable moulding pressure.

14120/13. FARBENFABRIKEN VORMALS F. BAYER & CO. **Hydrastinine.**

Hydrastinine is prepared by treating dihydrohydrastinine with iodine. The hydriodide of hydrastinine results, and can be converted directly or through the free base into the hydrochloride.

14220/13. M. WASSERMANN. **Paints.**

A preservative paint for wood, metal, stone, ships, etc., is made by sulphonating train or fish oil with strong sulphuric acid, treating the product with suboxide of copper so as to form a copper salt of the sulpho-fatty acid, and heating the mixture with litharge to convert the copper sulphate present into copper oxide and to form lead sulphate. The paint contains the copper salt of the sulpho-fatty acid, metallic copper, copper oxide, lead sulphate, and an excess of suboxide of copper. Filling materials, such as barium sulphate, kieselguhr, iron oxide, etc., may be added.

14226/13. J. MÜHLBAUER. **Chromates; Chromium Oxides.**

Chromium oxide, or a substance yielding it, such as chromium hydroxide, is heated alone or with an alkaline earth or heavy metal oxide, or substances yielding such an oxide, such as a hydrate, in air or oxygen under pressure, to obtain chromium pigments. The products mentioned are a black chromium oxide and the chromates of the alkaline-earth metals, magnesium and iron.

14249/13. O. LOBECK. **Sterilising Milk, etc.**

In sterilising milk or other liquid by heating it in the form of spray, a current of hot air, steam, etc., is used to modify or break and so ensure uniform heating.

14632/13. L. WEISS. **Enamels.**

Opauing agents for enamels consists of the fluorides or double fluorides of tin, antimony, titanium, or zirconium, which on firing are decomposed by water either present in the enamel mass or freed by decomposition of substances present in the enamel. The opauing effect is increased by the presence of hydroxides of the alkalis and alkaline earths or silicon compounds. Basic fluorides may be used.

14695/13. J. EDMUNDS. **Insecticides. Fertilisers, etc.**

A mixture for destroying slugs, insects, and other garden pests consists of slaked and ground calcium carbide and a carrier, such as soft soap. A colouring agent, such as permanganate of potash, may also be added. The mixture serves also as a fertiliser.

14778/13. A. PHILIP. **Oils.**

An oil for use as fuel is obtained by dissolving up to about 8% of naphthalene in otherwise untreated crude or heavy petroleum oil. The addition of the naphthalene reduces the viscosity of the oil and thus enables it to be readily pumped or otherwise handled.

CORRESPONDENCE.

The Editor of THE CHEMICAL WORLD.

DEAR SIR,—We notice some remarks by Mr. C. T. Nesbitt in your November issue on our method of "Mechanicalised Analysis."

May we in the first place point out that, whereas he terms our system "tabloid analysis," and repeatedly uses the word "tabloid" in this connection, as we stated in the discussion of the particular paper to which he refers (*Journal of the Iron and Steel Institute*, 1911, p. 373): "It was only right that they (the authors) should point out that that was the registered trade mark of a well-known firm, and ought not to be applied to tablets referred to by the authors."

The system, however, does not essentially consist in the mere addition of chemicals in tablet form, but in the whole arrangement of the methods so as to eliminate and reduce variable factors; analysis being conducted under automatically fixed conditions ensuring precision all through, the prime object having from the first been to increase the inherent accuracy, because on such lines alone is it possible to solve the question of standard methods.

The most skilful surgeon does not disdain to use the finest instruments he can procure to aid his precision. Why should similar aids to the analysts be regarded as only "useful for semi-skilled assistants," and the procedure carefully planned for exactitude be termed "a mere sequence of operations"? Incidentally there is a distinct saving in time, and expense for labour, apparatus, etc. There is less use of the "bottom-fed" burettes, to which he refers, other glass-ware, molybdate, etc. Since the first paper on the subject, which alone he mentions, five others have been given in which these points are dealt with.

As to utility, the best proof is that, although these preparations were not intended from the first for the object of sale for gain, but for private use in scientific interests, yet, through one firm telling another, the use has increased to a rate of about a million a year in places all over the world.

C. H. RIDSDALE.

N. D. RIDSDALE.

Middlesbrough,

November 25th, 1914.

ENGINEERING NOTES.

By R. J. DUNDERDALE, B.A. (CAMB.), A.M.I.C.E.

Timber in Factory Construction.

An effort is being made to reintroduce timber into factory construction, especially in roof trusses—a situation in which a year or two back it was hardly ever thought of. This has been greatly brought about by the substitution of fairly thin slight roof truss scantlings in place of the large and heavy beams of two or three generations ago, and this again is due to a better understanding of design in such structures. Several suitable designs have been evolved for this class of roofing and are to be seen in many parts of this country in steel working machine shops of very considerable span. The roof trusses are usually of lattice design, sometimes with and sometimes without one main tie.

A specious objection to this type of roof is generally found in fire dangers, but, as the manufacturers of this class of roof are at pains to point out, fire does not usually originate in the roof, but in the body of a building, and in

such a case roof failure may take place very quickly indeed, even with an iron roof, if intense local heating is set up anywhere. In such a case wood often offers an advantage, for collapse will not take place before the truss is practically burned through, whereas the local overheating of a mild steel tie rod may bring about a very speedy failure.

Another and really more frequent cause of wooden roof failure and, indeed, of wooden structures in general, is dry rot, and a paper on this subject was contributed early this year to the American Society of Mechanical Engineers by Mr. F. J. Hoxie. He ascribed failure from this cause to careless specification of timber by the erector and to deficiency in resins of the timber itself, and put the resin contents necessary to withstand the fungus at least 3%. This may or may not be right. In the discussion which followed Mr. H. von Shrenk stated that the presence of sap wood usually accounted for dry rot.

Be this as it may, where wooden structures are concerned, if only a very temporary structure be aimed at the matter seems to be of little importance, but should permanence be desired, resin or no, probably the only thing to be done is to use good seasoned timber properly creosoted, or covered with a suitable paint to exclude air and moisture.

Critical Speeds of Tool Steel.

In volume 82 of the *Revue d'Artillerie* there is an article by Captain P. Dennis on the varying effects of speed and feed on the tool steel of the tools employed in cutting various irons, bronzes and steels.

The article is divided into two parts, and in the first the relation between cutting speed and tool temperature is studied. It has, of course, been known for a long time that most "speedicut" tool steels were more efficient at a considerable temperature than when cold, and Captain Dennis shows that for certain classes of high-speed tool steel there are two temperature points of maximum output with a temperature point of minimum output lying almost midway between them. Above the second critical maximum lies a temperature of no output corresponding in practice, we may suppose, to the edge of the tool being almost immediately rubbed off. For a special chrome tungsten steel investigated, which was quenched from 1,300 °C. in molten lead, the first maximum occurred at 215° C. and the second at 290° C., with a minimum output temperature point of 250° C. between; above 290° the output fell off, until at 340° C. it became *nil*. The results are given in a series of temperature-output curves. It will at once appear that four factors control these results: speed of cut, amount of feed, depth of cut, and lubrication (if any).

As these variables are all interdependent the author, for the purposes of the second part of his investigation, arbitrarily fixed the depth of cut at about .2 inch and the amount of feed per revolution at .02 inch; the peripheral speed of the cut substance was then varied to give the various temperatures of maximum and minimum output. A list is given for the various substances (previously mentioned), and, taking the case of medium steel as the cut substance, the first maximum occurred with a cutting speed of 66 ft. a minute, the second maximum at 95 ft. a minute, and the minimum at 82 ft. a minute. At first sight it appears that the minimum should give a larger output than the first maximum, but, owing to the more frequent regrinding required, this is not the case. Other feeds and cutting depths, the author shows, can be accounted

for by the formula $O = C$ when $S = \frac{K}{\sqrt[3]{f^2 \times d}}$, where O

is the output and C and K are constants and f = the feed and d the depth of cut. This can, of course, be again combined with the prices of various tool steel considered. The article is well illustrated by curves and diagrams displaying the data the author obtained in his research. A very interesting point not gone into by the author is how and why the chemical content of the tool steels are influenced by the temperature so as to produce the various outputs.

A New Source of Potassium Salts.

In "La Technique Modern," vol. 8, appears an account of a French venture boring for coal and oil in Alsace in the vicinity of Mülhausen. Not much is said about the main object of these excavations, but at 200 metres a seam of salt, consisting of sodium and potassium chloride, was found, which was about one and a half metres thick, and at 700

metres in depth. Another of about four and a quarter metres in thickness was discovered, and the proprietors reckoned they might have about 300 million tons of the crude mixed salt to deal with. The sinking of one of the shafts is described, and it is noted that at the first level mentioned there was a dangerous inflow of water. The filtration of water anywhere is clearly to be guarded against, owing to the extremely soluble nature of the two salt seams. The salt was worked, and the potassium salt separated from the sodium by taking advantage of the fact that, while both salts are soluble in cold water, the ratio of solubility of the potassium salt to that of sodium rapidly rises with the temperature of the solvent water. On the other hand, it should be mentioned that a good deal of the salt was crushed when raised. From this one infers the potassium content is small for two sound reasons: its poisonous properties and its greater commercial value.

REVIEWS OF BOOKS.

"A TEXT-BOOK OF PHYSIOLOGICAL CHEMISTRY."

By Olaf Hammarsten and S. G. Hedin. Translated by J. A. Mandel. Seventh Edition. CHAPMAN & HALL, London. Pages 1026 + viii. Price 17/- net.

The matter dealt with in this important work is one which is subject to almost continual revision, owing to the influence of more recent investigation. From this point of view alone this last edition will be welcomed by all those interested in biological chemistry. The work is divided into some thirty-seven chapters, and has been thoroughly revised and also well translated by Professor Mandel. One of the features of the book is the long index of authors. A glance at this will indicate how much of the detail work owes its origin to foreign investigators. This work can be recommended to students who specialise in this direction.

"AN INTRODUCTION TO THE STUDY OF PHYSICAL METALLURGY."

By W. Rosenheim, F.R.S. CONSTABLE & Co., London. Pages 368 + xvi. with 31 Plates and 131 Text Figures. Price 10/6 net.

This work serves at the present juncture to bring to notice the general development which has taken place in the physical investigation of the structure of metals and alloy systems.

It is divided into some fourteen chapters, and is a valuable work for the student who is taking up this subject, or as a general text-book for the more advanced worker in metals. The microscopic examination of metals necessarily takes up considerable space, and very detailed instructions are given concerning procedure in this direction. Naturally the thermal study of metals and alloys also comes under detailed discussion, as also their mechanical testing.

This work is, as would be expected, a thoroughly efficient introduction to a very difficult subject, and sets a high standard to those who are following in this same series of text-books. It is exceptionally

well illustrated, and is not overcrowded with unnecessary detail, which so often masks the efficiency of modern text-books.

"MOLECULAR PHYSICS." By J. A. Crowther. J. & A.

CHURCHILL, London, 1914. Pages 167 + viii, with Bibliography and Appendices. Chapters IX., with 28 Illustrations. Price 3/6 net.

As this work has already appeared in serial form in this journal, it is hardly necessary to discuss it in detail.

The author claims that it is an attempt to give a connected account of the constitution of the atom and molecule in the light which has been thrown upon these particles by recent physical research. From his experience, and position, the writer is undoubtedly qualified to undertake this task, and put before the average chemist the results which have been obtained in the Cavendish Laboratory and elsewhere. Appendices and a short bibliography have been added in this volume.

"PRACTICAL SCIENCE FOR ENGINEERING STUDENTS." By H. Stanley. METHUEN & Co., LTD.,

London, 1913. Pages 162 + vi, with Index and Appendix. Parts V., with 92 Illustrations. Price 3/-.

This work is admittedly of an elementary character, and is written for the use of evening students. To the general chemist who has but little knowledge of engineering, and the problems involved, this small work will have an interest, but generally speaking there has been a tendency to deal with too many subjects in the space at the disposal of the author.

"EXPERIMENTS ARRANGED FOR STUDENTS IN GENERAL CHEMISTRY." By E. F. Smith and H. F.

Keller. Shorter Course. P. BLAKISTON'S SON & Co. Philadelphia, U.S.A., 1913. Pages 54. Divided into 2 Parts. Chapters XXII., with 12 Figures. Price 60 cents net.

This volume is intended as a very elementary guide to the student who comes for the first time

in contact with practical chemistry. The arrangement of the text is of a somewhat irritating character, but it is possible that the book will be found of value when used by students working under the authors in their respective departments.

"CHEMISTRY INORGANIC AND ORGANIC," with Experiments. By Charles Loudon Bloxam. Tenth Edition. Rewritten and Revised by Arthur G. Bloxam and S. Judd Lewis. J & A. CHURCHILL, London, 1913. Pages 878 + xi, with Index and 313 Illustrations. Price 21/- net.

The tenth edition of this important text-book has been thoroughly brought up to date. The recent developments in physical chemistry have necessitated the recasting of the earlier portion of the work, and, generally, the value of the work, as one of reference, and as a general text-book, has been greatly increased.

Dealing as it does with both inorganic and organic chemistry, it forms a valuable text-book for the college student, and there can be little doubt but that it will continue to occupy the position secured by the earlier editions.

"CLAY AND POTTERY INDUSTRIES," Vol. I. Collected Papers from the County Pottery Laboratory, Staffordshire. Edited by J. W. Mellor. CHARLES GRIFFIN & Co., LTD., London, 1914. Pages 411 + xiv, with Index. Chapters LII., with 263 Illustrations and 4 Coloured Plates. Price 15/- net.

This volume is essentially practical in its nature, for it records research conducted by several well-known investigators in the problems connected with the pottery industries.

It is well illustrated, and should be on the book-shelf of every technical chemist, for the information

contained must at some time or other be of value to almost every worker in technical chemistry.

"A TEXT-BOOK OF QUANTITATIVE CHEMICAL ANALYSIS." By Alexander Charles Cumming and Sydney Alexander Kay. GURNEY & JACKSON, London, 1913. Pages 382 + xi, with Appendix and Indices. Parts X., with 96 Illustrations. Price 7/6 net.

The authors claim this work as a text-book for those university students who have only a comparatively short time to devote to chemistry as a subsidiary subject. From this point of view the work admirably serves its purpose. The different sections deal respectively with general principles, volumetric analysis, gravimetric analysis, colourimetric methods, analysis of simple ores and alloys, gas analysis, water analysis and other subjects of equal interest to the student. This work can be thoroughly recommended.

BOOKS RECEIVED.

"The Elements of Physical Chemistry," by J. Livingstone R. Morgan. Fifth Edition. Chapman & Hall, London. Pages 506 + xvi. Price 12/6 net.

"A Text-Book of Inorganic Chemistry," Volume I. Edited by J. Newton Friend. C. Griffin & Co., London. Pages 386 + xvi, with 90 Illustrations. Price 10/6 net.

"Elementary Practical Chemistry," by J. E. Myers and J. B. Firth. C. Griffin & Co., Ltd., London. Pages 194 + viii., with Diagrams. Price 4/- net.

"Abstracts of Current Decisions on Mines and Mining, March to December, 1913," by J. W. Thompson. Bulletin 79, Bureau of Mines, Washington, U.S.A. Pages 140.

"The Problems of the Petroleum Industry," by I. C. Allen. Technical Paper 72, Bureau of Mines, Washington. 1914. Pages 19.

COMMERCIAL AND TRADE REVIEW.

GENERAL NOTES.

Detection of Resinous Oil in Mineral Oils.

A writer in "Nachrichten der Zollstellen," 1914, states that of late mineral oils for lubricating purposes have been adulterated by admixture of aniline dyes which prevent the fluorescence of these oils. Although the presence of aniline dyes does not deteriorate the value of the oils as lubricating agent, it interferes with the test for the contents of resin in mineral oils (this estimation being part of the Custom analyses carried out before mineral oils are classified for duty). When mineral oils show no splendid lustre, *i.e.*, fluorescence, they are generally adulterated by an admixture of yellow aniline dye, which produces red to purple colouration in presence of an acid, this interfering with a similar colouration due to resinous oil. If mineral oil contains aniline dye, the lower portion of a test solution becomes red during the addition of hydrochloric acid; the actual test being carried out as follows: 10 c.c. of the mineral oil to be tested are brought into a separating funnel containing 10 c.c. hydrochloric

acid of 1.125 density, the mixture being then so long agitated till the lower portion of the liquid is no longer coloured red. The upper portion of the liquid is again agitated with 10 c.c. water, and the whole set aside. In case of a mineral oil being especially tough-pitch, it is recommendable to dilute the liquid by adding ether, which, however, must be removed again (after setting aside for a while) through warming continuously and passing a stream of air through the mixture. After this the oil to be analysed is freed from acid-soluble dyes and can be tested as usually with sulphuric acid and acetic acid anhydride.

The Panama Canal stimulates Magnesite Mining.

The largest magnesite deposits in California were recently purchased by a new company, and are now being reopened and worked. Several thousands of tons will be delivered monthly and shipped to the Atlantic seaboard *via* the Panama Canal. California has been the only State in the United States to produce magnesite on a commercial basis, and most of the material has been consumed there in the manufacture of paper, in which it is used as a digester

for wood pulp, and in making plastic flooring, tiles and fire-proofing materials.

New Method for Hardening Steel.

Reports have been made in Germany of the discovery of a simple process for hardening cast or forged steel, which does not destroy the effect of previous heating treatment nor cause the metal to undergo a change in form. In hardening a gear, for instance, the whole of a tooth is not heated, but, on the contrary, only its surface to a depth of approximately $\frac{1}{16}$ in. A high-temperature flame is played over the surface with a brush-like motion. Upon its removal the cooling takes place immediately, the heat radiating into the cool mass of steel and into the atmosphere. In this way the highly hardened part of the steel consists of an outer surface film. By increasing the time of application of the flame, the hardened part may be deepened to $\frac{3}{16}$ in., the blaze in such a case being given a rotating motion to avoid burning the metal.

The Production of Carbohc Acid in the United States.

Evidence that the difficulties now experienced in obtaining carbohc acid of foreign origin in the American markets are leading to a more extensive production of that commodity in the United States is furnished by the fact that several chemical firms are contemplating considerable extensions of their plant. A large concern at West Orange, N.J., are making virtually all the phenol crystals which they require at their laboratory and works, and several other companies, hitherto manufacturing coal-tar products, are planning to augment their output of carbohc acid materially. The advance of the price of foreign carbohc acid has amounted to almost 600% since the outbreak of the war. It is, therefore, practicable for American chemists to produce the acid profitably despite the relatively high costs of labour.

Soaps from Infusorial Earth.

Infusorial earth is being mined very actively in California and Nevada, which produced nearly 90% of the 6,528 tons, the output last year in the United States. The value of the product averaged \$10.50 per ton. Diatomaceous or infusorial earth has until now been largely used as an abrasive in the form of polishing powders and scouring soaps, but the American Geological Survey states that of late its uses have been considerably extended. On account of its porous nature it has been used in the manufacture of dynamite as a holder of nitroglycerine, but its use does not apply so far as known to the United States. In Europe, especially Germany, infusorial earth has lately found extended application. It has been used in preparing artificial fertilisers, especially in the absorption of liquid manures, in the manufacture of water-glass, of various cements, of glazing for tiles, of artificial stones, of ultramarine and various pigments, of aniline and alizarine colours, paper, sealing wax, fireworks, gutta-percha objects, Swedish matches, "solidified bromine," scouring powders, *papier-maché*, and many other articles. The demand for the product is rapidly growing.

West Indian Orange Oil.

According to the *Journal of the Jamaica Agricultural Society*, there was practically no sale for West Indian orange oil in London until the Messina earthquake destroyed large stocks of Sicilian produce. At that time Jamaican producers did their best to meet the demand at the higher prices offered, and they succeeded in showing

that West Indian oil, though slightly different, could be substituted for oil previously used. The Jamaica industry suffers from lack of centralisation, the oranges being spread over pastures and hillsides, whereas in Sicily they are grown chiefly in groves, and are rinded in central factories. The Jamaican peasants are sent out with hand-machines and bottles to collect and rind the fruit under the trees, the bottles containing, after rinding the fruit, a mixture of oil, mucilage, and juice. The bulk of the oil produced is handled by two firms of London merchants who act as agents for the producers.

M. L.

CONSULAR AND OFFICIAL REPORTS.

Chemicals in Japan.

The importation of industrial and pharmaceutical chemicals into Japan is on a large scale, and amounts to about £1,500,000 yearly, the principal items being those used in the match, paper, glass and soap industries. As these manufactures have been progressing during the last year, business in heavy chemicals may be said to have been good. The importation of soda ash, caustic soda, chlorate of potash and phosphorus amounted to over £450,000.

With regard to chlorate of potash, it is of interest to note that the works near Lake Inawashiro, in the north, are now said to be producing on a large scale, but it is difficult to get statistics as to output.

In acetate of calcium there has been a large advance from 5,272,000 lbs., worth £30,000, to 9,100,000 lbs., valued at £56,000. This came entirely from America. It is said that the increase is accounted for by the progress made in the manufacture of acetic acid in this country, which is probably correct, as the importation of this latter article has dropped to £150. In glycerine there is a falling off from £80,000 to £67,000, and this may become more accentuated when the plants which have recently been started get into full swing. The chief purchasers are the military authorities and the Monopoly Bureau, the latter using it for the preparation of tobacco. About 60% of the supplies came from the United Kingdom, and most of the balance from Germany.

Amongst pharmaceutical chemicals by far the largest gain is credited to morphine, the importations of which were valued at £50,000, as compared with £15,000 in 1912 and £10,000 in 1911. Most of it came from the United Kingdom and was re-exported in one form or another.

Superphosphate Production in Piedmont.

In his report on the Agriculture and Industries of Piedmont for the year 1914, H.M. Consul at Turin remarks that the production of superphosphates in the Vercellese district is of noteworthy importance, and is estimated to exceed 600,000 quintals per annum, of a value of £140,000. It is largely employed for growing rice. There was, however, an acute crisis in this industry owing to over-production, and all the factories of northern Italy formed a trust for the reduction of the quantity manufactured, which has diminished by 30%. This industry suffers also a good deal from competition of *Scorix Thomas* (dross) largely imported from Germany and the United Kingdom.

Essential Oils from Seychelles.

In a report on Seychelles for the year 1913 it is stated that the distillation of essential oils from the lemon-grass, cinnamon leaves and cloves, etc., has made great strides. A new still, capable of large distillation, was erected during the year in Barbarons estate by the enterprise of

Mr. d'Emmerez de Charmoy. Specimens of lemon grasses were obtained from Ceylon and distributed amongst planters. A small supply of citrate of lime was made at Silhouette Island, mostly from bigarades. The cultivation of citrus fruits also received some attention during the year, but they are liable to attacks of the scale insects.

Fertiliser and Chemical Trade of Italy.

According to a recent report received at the Bureau of Foreign and Domestic Commerce the "Unione Concimi Chimici" (Fertiliser Trust) of Milan, which controls two-thirds of the sales of chemical fertilisers in Italy, spent \$400,000 on improvements at its plant at San Gallo last year, but was obliged to demolish the one at Vicenza on account of the complaints of the townspeople. This company which has factories throughout the kingdom and is capitalised at \$5,000,000, owns large tracts of land near Tripoli, in Africa, whence it imports its raw material.

The increasing demand for *sulphate of ammonia* is expected to continue as the season advances. This material is chiefly imported from Germany.

MARKET REPORTS.

LONDON.—During the period under review a very satisfactory adjustment to the new conditions caused by the European war has taken place in commercial circles, and as time goes on renewed confidence is being shown in almost every quarter. This process of re-establishing general confidence has been helped by the more favourable export returns for October, which showed an increase of nearly £2,000,000 against the preceding month. The figures referring to the export trade in chemical products may be considered particularly satisfactory, since they show a gain of £208,000 in comparison with the September figures, while the exports of chemicals, drugs, dyes, etc., reached a total of £1,570,207, thus showing an increase of £335,000 against the second month of the war.

The imports of chemicals, drugs, dyes, etc., during October have also considerably increased in comparison with September, though they are still much below those of the corresponding month of last year.

The home trade in chemicals is gradually improving. The opening of the Liverpool cotton market and the increased activity in the spinning industry seem to favour an early improvement in the demand from textile manufacturers. The general prospects for the immediate future are considered fairly promising.

Very little business has been done in chemical fertilisers. Sulphate of ammonia is again quieter, and the recent upward movement of prices has received a check. The quotation for prompt delivery is about £10 10s., but for spring contracts a premium of 5s. to 7s. 6d. is asked. Nitrate of soda remains lifeless, the demand from agricultural interests being quite insignificant. The nominal price is, therefore, barely steady at 10s. for ordinary and 10s. 6d. for refined quality.

In the market for tar products irregularity prevails. Those articles which are required in connection with the war are in active demand and strong, while others suffer more or less from continued neglect. In the latter category pitch offers a striking example of complete lack of vitality, the home inquiry being poor, while shipments continue insignificant. It is generally believed that only extensive price concessions would tempt buyers to act. The nominal quotation is about 32s. The shipments of benzol and toluol during October amounted to 363,822 gallons, against 517,155 gallons in the corresponding month of last year.

It is hoped that the export demand for benzol, especially from France, will further grow as the home consumption for motor purposes is very small. Ninety per cent. quality is quoted at 9½d. to 10d. per gallon. Toluol belongs to the articles required largely for war purposes, a fact which accounts for the great scarcity and extreme prices. Business is said to have been done at 2s. 4d. per gallon. Carbolic acid, too, is very scarce, and in good demand at 2s. 7d. to 2s. 8d. per gallon (crude 60% East Coast), while crystals are held at 11d. to 1s. per lb. The rush for solvent naphtha has slightly diminished, but there is still a satisfactory demand from rubber manufacturers. White solvent is quoted at 10d. per gallon, and heavy at 1s. 1½d. to 1s. 2d. in casks. The inquiry for naphthalene is still very active, and fine qualities of crude find ready purchasers at 60s. to 95s. per ton.

MANCHESTER.—The better position of the cotton industry is reflected by an improved demand for chemicals. Bleaching powder has shown increased animation, which caused renewed strengthening of values. The quotation for hard wood is £7 15s. Caustic potash remains scarce and prices are continually hardening. Prussiate of potash favours sellers, most of whom ask 1s. 4½d. per lb. Acetic acid is steady at from £42 10s. to £45 per ton for 99% to 100% glacial, and at £29 to £30 for 80% commercial in casks. This description is slightly easier in consequence of increased arrivals. Acetone is very scarce at about £90 per ton for Government specification quality.

LIVERPOOL.—The outlook for the trade in chemicals is considered much brighter. Large Government orders, in addition to active export demand, have caused an improved tone and a further stiffening of prices in some directions. Caustic soda is finding renewed attention at rising prices. Bicarbonate of soda has been fairly active, and sellers have obtained £5 10s. per ton, in bags, f.o.b. for export. Oxalic acid is in fair demand at 8½d. per lb. Cream of tartar (98% quality) finds buyers at £8 5s. to £8 10s. per cwt.

Metal Markets.

LONDON.—The most interesting feature of the metal market has been the resumption of official trading on the Metal Exchange. Though actual business was not very lively, the position seems to be gradually improving. This refers especially to the copper market, where a sharp upward move has taken place. A fair amount of business is reported at £54 for three months warrants. The market has received much assistance from American speculators and consumers, the latter covering their requirements more freely. Electrolytic developed increased firmness, though the closing price, e.g., £56, was 5s. lower than the highest level touched shortly after the opening of the market. Manufactured copper has been more active. The initial transactions in tin showed an advance of 20s. to 30s. per ton on the previous big rise, but the tone has since been irregular in spite of a further large decrease in spot supplies. Leading importers are now more inclined to meet the forward demand, but the statistical position of the article is still extremely strong. Standard cash tin is officially quoted at £135 15s. to £136 2s. 6d., and three months at £135 10s. to £136. The manufacturing industries, such as tinplates and galvanised iron, are still in a disappointing condition, particularly the latter, as the export demand continues small. The much reduced output of galvanised iron tends to restrict the consumption of spelter, although the value of this metal has gone up. American spelter for December delivery is held at £25 5s. to £25 7s. 6d. English lead is firm at £18 15s. and foreign prompt at £18 7s. 6d.

INDEX TO THE CHEMICAL WORLD.

January, 1914—December, 1914, inclusive.

Subject, Author, and Sectional.

A.		PAGE			PAGE			PAGE
Acetic acid, in Uruguay	242	Camphor from Formosa	126	Cohen, J. B. (" Fate of the Glucose		Molecule in Fermentation ")	39	
Acetone oil, inquiry for	30	Camphor industry in Japan	266	Cohen, J. B. (" Kaiser-Wilhelm In-		stitute for Chemistry ")	169	
Acid elevator, Schutze's automatic .	30	Camphor planting in Phillipines . .	156	Colloidal Chemistry in 1913			71	
Acidity of fruit juices	79	Canada's forest products labora-	185, 315	Colour Using Industries, effect of		the war on	318	
Adulterated oils in U.S.A.	61	tories		Combustion, spontaneous			152	
Adulteration in Belgium, treatment		Canadian Board of Agriculture . . .	92	Commercial and General Notes,		Trade Review, etc.	28, 60, 92, 123,	
of	105	Canadian inquiries	315	156, 184, 213, 240, 265, 289, 313, 333				
Aeroplanes, chemical factor in safety		Carbide of calcium in Brazil	157	Adulterated oils in U.S.A.			61	
of	205	Carbolic Acid, Production of, in		Alkalies from rocks			313	
Alcohol motor fuel	186	U.S.A.	337	Ammonia, source of			185	
Alkalies from rocks containing alkali		Casein obtained by electrolysis . . .	62	Ammonium sulphate in China			28	
Allmand, A. J. (" M. V. Lomonosov		Casein, substitute for	241	Arsenical dipping fluids			240	
—An Early Russian Chemist ") . .	219	Caspari, W. A. (" The Education of		Asbestos in Arizona			240	
American finance	127	Industrial Chemists ")	191	Australia's gum trees			313	
Ammonia in rain water	185	Catalysis and its Industrial Applica-		Bay Rum and Florida Water in				
Ammonium sulphate in China	28	tions . 17, 47, 81, 108, 147, 171, 199,		Canada			290	
Argentina, borax and salt in	94	230, 255, 283, 326		Bean butter, Japanese			212	
Armstrong, H. E. (" A Move towards		Cathodic reduction of organic nitro-		Biology, applied			314	
Scientific Socialism ")	67	compounds	76	Borax mineral, origin of			157	
Armstrong, H. E. (" The Significance		Cellulose, surgical bandages of . . .	92	Boric acid and borax ore			29	
of Optical Properties ")	3	Ceylon, drugs and medicines in . . .	157	Boric acid in bleaching			241	
Arsenic in soils	85	Chemical fertilisers in Belgian		British India, chemicals in			124	
Arsenical dipping fluids, oxidation		Colonies	186	Camphor planting in Philli-			156	
of	240	Chemical fire extinguishers	157	panies				
Artificial manure at Reval	30	Chemical Industries :—		Canadian Board of Agriculture			92	
Asbestos in Arizona	240	Adulteration in Belgium	105	Canadian forest products labora-			185	
Australia's gum trees	313	Cathodic reduction of organic		Carbolic Acid, Production of, in				
Alloys, nomenclature of	24	nitro-compounds	76	U.S.A.			337	
		Electrolytic Preparation of		Casein, substitute for			241	
		" Per-Salts "	254	Cellulose, surgical bandages of . .			92	
		Food adulteration in England . . .	7	Chemical fire extinguishers			157	
		Methods for determining the		Chemicals, U.S. tariff on			93	
		oxygen absorption of drying		Chemicals, wrapping material			289	
		oils	300	for				
		Mexican graphite deposits	45	Chemists in German army			290	
		Oils, fats and milk products . 43, 107,	197	China, disinfectants in			240	
			135	Coal tar production in U.S.A. . . .			314	
		Salt industry, the	135	Cocoa butter, adulterated			184	
		Sterilisation of water by means		Cyanide in U.S.A.			290	
		of light	223	Denmark, casein industry of . . .			156	
		Treatment of waters containing		Dye compounds			185	
		iron or manganese	44	Dyes, imports of, in Changsha . .			29	
		Use of organic compounds in		Fertiliser industry			29	
		metallurgical practice	9	Fertilisers for Brown Tennessee				
		Viscosity of rubber solutions . . .	224	rock			290	
		Chemical industry of U.S.A.	60	Fire extinguisher, a cheap			184	
		Chemical manures in China	291	Flavouring Extract Alcohol Bill			123	
		Chemical Societies, International		French artificial wood			290	
		Association of	1	Garnet, abrasive			241	
		Chemical trade of Mannheim	267	Gas, illuminating			213	
		Chemicals, apparatus for automatic		Gelatin, examination of			185	
		measuring and injection of	198	Gelatine, shortage in England . .			314	
		Chemicals in Dresden	215	German coal tar colours			157	
		Chemicals in Japan	266, 337	German dairy institute			93	
		Chemicals, U.S. tariff on	93	German East Africa, technical				
		Chemicals, wrapping material for . .	289	department for			93	
		Chemist in his relation to manufac-		German potash producers			93	
		turing industry	74	German sulphate of ammonia				
		Chemists in German army	290	industry			92	
		China, disinfectants in	240	Glass manufacture in Hungary . .			265	
		Coal, complete gasification of . . .	87	Graphite as a lubricant			290	
		Coal tar production in U.S.A. . . .	314	Guano discovery in Peru			265	
		Cochet, A. (" The Construction of		Hong Kong opium traffic			61	
		Furnaces for the Manufacture of						
		Chemicals ")	115					
		Cocoa butter, adulterated	185					
		Cohen, J. B. (" The Discovery of						
		Oxygen ")	247					

B.		PAGE			PAGE			PAGE
BAVARIA, graphite deposits in . . .	241	Camphor from Formosa	126	Cohen, J. B. (" Fate of the Glucose		Molecule in Fermentation ")	39	
Bay Rum and Florida Water in		Camphor industry in Japan	266	Cohen, J. B. (" Kaiser-Wilhelm In-		stitute for Chemistry ")	169	
Canada	290	Camphor planting in Phillipines . .	156	Colloidal Chemistry in 1913			71	
Beadle, C., and Stevens, H. P.		Canada's forest products labora-	185, 315	Colour Using Industries, effect of		the war on	318	
(" Viscosity of Rubber Solu-		tories		Combustion, spontaneous			152	
tions ")	224	Canadian Board of Agriculture . . .	92	Commercial and General Notes,		Trade Review, etc.	28, 60, 92, 123,	
Beam, W. (" The Determination of		Canadian inquiries	315	156, 184, 213, 240, 265, 289, 313, 333				
Humus in Heavy Clay Soils ") . .	209	Carbide of calcium in Brazil	157	Adulterated oils in U.S.A.			61	
Bean butter, Japanese	242	Carbolic Acid, Production of, in		Alkalies from rocks			313	
Bean oil extraction by benzine mill .	291	U.S.A.	337	Ammonia, source of			185	
Benares pharmaceutical trade . . .	125	Casein obtained by electrolysis . . .	62	Ammonium sulphate in China			28	
Biology, applied, new publication on	314	Casein, substitute for	241	Arsenical dipping fluids			240	
Bolton, E. R., and Revis, C. (" Oils,		Caspari, W. A. (" The Education of		Asbestos in Arizona			240	
Fats and Milk Products ") . 43, 107, 197		Industrial Chemists ")	191	Australia's gum trees			313	
Books, etc., received . 28, 58, 90, 118,		Catalysis and its Industrial Applica-		Bay Rum and Florida Water in				
154, 181, 205, 238, 262, 286, 311, 336		tions . 17, 47, 81, 108, 147, 171, 199,		Canada			290	
Borax mineral, origin of	157	230, 255, 283, 326		Bean butter, Japanese			212	
Boric acid and borax ore in Cali-		Cathodic reduction of organic nitro-		Biology, applied			314	
fornia	29	compounds	76	Borax mineral, origin of			157	
Boric acid in bleaching	241	Cellulose, surgical bandages of . . .	92	Boric acid and borax ore			29	
Brass rods, season cracking in . . .	235	Ceylon, drugs and medicines in . . .	157	Boric acid in bleaching			241	
Briquetted or " Patent " fuels . . .	307	Chemical fertilisers in Belgian		British India, chemicals in			124	
British India, imports of chemicals		Colonies	186	Camphor planting in Philli-			156	
into	124	Chemical fire extinguishers	157	panies				
Bronze	149	Chemical Industries :—		Canadian Board of Agriculture			92	
By-product coking	25	Adulteration in Belgium	105	Canadian forest products labora-			185	
		Cathodic reduction of organic		Carbolic Acid, Production of, in				
		nitro-compounds	76	U.S.A.			337	
		Electrolytic Preparation of		Casein, substitute for			241	
		" Per-Salts "	254	Cellulose, surgical bandages of . .			92	
		Food adulteration in England . . .	7	Chemical fire extinguishers			157	
		Methods for determining the		Chemicals, U.S. tariff on			93	
		oxygen absorption of drying		Chemicals, wrapping material			289	
		oils	300	for				
		Mexican graphite deposits	45	Chemists in German army			290	
		Oils, fats and milk products . 43, 107,	197	China, disinfectants in			240	
			135	Coal tar production in U.S.A. . . .			314	
		Salt industry, the	135	Cocoa butter, adulterated			184	
		Sterilisation of water by means		Cyanide in U.S.A.			290	
		of light	223	Denmark, casein industry of . . .			156	
		Treatment of waters containing		Dye compounds			185	
		iron or manganese	44	Dyes, imports of, in Changsha . .			29	
		Use of organic compounds in		Fertiliser industry			29	
		metallurgical practice	9	Fertilisers for Brown Tennessee				
		Viscosity of rubber solutions . . .	224	rock			290	
		Chemical industry of U.S.A.	60	Fire extinguisher, a cheap			184	
		Chemical manures in China	291	Flavouring Extract Alcohol Bill			123	
		Chemical Societies, International		French artificial wood			290	
		Association of	1	Garnet, abrasive			241	
		Chemical trade of Mannheim	267	Gas, illuminating			213	
		Chemicals, apparatus for automatic		Gelatin, examination of			185	
		measuring and injection of	198	Gelatine, shortage in England . .			314	
		Chemicals in Dresden	215	German coal tar colours			157	
		Chemicals in Japan	266, 337	German dairy institute			93	
		Chemicals, U.S. tariff on	93	German East Africa, technical				
		Chemicals, wrapping material for . .	289	department for			93	
		Chemist in his relation to manufac-		German potash producers			93	
		turing industry	74	German sulphate of ammonia				
		Chemists in German army	290	industry			92	
		China, disinfectants in	240	Glass manufacture in Hungary . .			265	
		Coal, complete gasification of . . .	87	Graphite as a lubricant			290	
		Coal tar production in U.S.A. . . .	314	Guano discovery in Peru			265	
		Cochet, A. (" The Construction of		Hong Kong opium traffic			61	
		Furnaces for the Manufacture of						
		Chemicals ")	115					
		Cocoa butter, adulterated	185					
		Cohen, J. B. (" The Discovery of						
		Oxygen ")	247					

	PAGE		PAGE		PAGE
Commercial and General Notes,		Consular Reports—(continued).		D.	
Trade Review, etc.—(continued).		Bean oil extraction by benzine		DAVIS, J. G. ("The Thermofeed	
Hydrogen under high pressure	265	mill	291	Differential Pump Governor")	124
Indiarubber factory, poisoning	185	Benares pharmaceutical trade	125	Davis, J. G., and Hawker, A. G.	
in		Camphor from Formosa	126	("Briquetted or Patent Fuels")	307
Institute of Industrial Research		Camphor industry in Japan	266	Davis, W. A. ("Simple Laboratory	
at Washington	123	Canada's forest product labora-		Apparatus for Continuous Eva-	
Iodine, in Holland	313	tories	315	poration of Large Volumes of	
Iodine, Japanese.	93	Canadian inquiries	315	Liquid in Vacuo")	239
Iodine, in Siberia	123	Carbide of calcium in Brazil	157	Davis, W. A. ("The Supposed Assi-	
Iodine number of linseed and		Casein obtained by electrolysis	62	milation of Sugars by Yeasts in	
petroleum oils	265	Ceylon, drugs and medicines in	157	the Absence of Fermentation")	271
Java, quinine factory in	60	Chemical fertilisers in Belgian		Denmark, casein industry of	156
Liquid air	241	colonies	186	Detection of caramel in non-saccha-	
Madagascar, monkey-bread tree		Chemical industry of U.S.A.	60	rine spirituous liquors	42
oil from	61	Chemical manures in China	291	Dewrance, J. ("Bronze")	149
Magnesite Mining, Panama		Chemical trade of Mannheim	267	Discovery of oxygen	247
Canal and	336	Chemicals in Dresden	215	Dreaper, W. P. ("Stratification in	
Metal sprayers, molten	241	Chemicals in Japan	266, 337	Mineral Deposits")	177
Mica and its uses	266	Copper industry, Russian	242	Dunderdale, R. J. ("Engineering	
Milk from Soya beans	93	Curacao phosphate mining	126	Notes")	24, 56, 87, 118, 152, 183,
New Zealand, new industry in	185	Electric potash, a new fertiliser	289	205, 235, 263, 287, 310, 334	
Nitrate in Chile	185	Essential oil, etc., in India	30	Dye compounds for destroying	
Nitrate industry, Norwegian	241	Essential Oils from Seychelles	337	diseased organisms	185
Oil, resinous, in mineral oils,		Fertiliser trade in Canary		Dyes, imports of, in Changsha	29
detection of	336	Islands	186		
Oil-hardening plant	92	Fertiliser and Chemical Trade		E.	
Oils, new, search for	93	of Italy	338		
Orange Oil, West Indian	337	Fertilisers in the Netherlands	125	ELECTRIC potash, a new fertiliser	289
Oxygen works in France	123	Glycerine factory in Mexico	215	Electro-Chemistry, the rise and pro-	
Palm saps	240	Gum collecting in New Zealand	267	gress of	323
Panama Exhibition	124, 184	Italy, chemicals in	94	Electrolytic iron manufacture	310
Patent medicine regulations in		Japan, ferilisers in	186	Electrolytic preparation of "Per-	
Cuba	29	Leipzig, chemical trade of	291	Salts"	254
Polarimetry, growth in applica-		Lignite as fuel	186	Engineering notes	24, 56, 87, 118,
tion of	289	Matches, Japanese, in India	94	152, 183, 205, 235, 263, 287, 310, 334	
Potash deposits in Spain	156	Mineral deposits in Trebizond	242	Essential oil, etc., in India	30
Potash industry, German	213	Nitrate industry, Chilian	266	Essential Oils from Seychelles	337
Potash salts in Germany	123	Nitrate of soda, Chilian	94	Experimental methods and their	
Potash in America	314	Norway, seaweed burning in	158	possible extension	163
Pottery glazing without heat	184	Norway, new cellulose and		Explosion engine fuels	287
Preservatives in lime juice cor-		paper mill	315		
dial	60	Olive oil, new process of refining	267	F.	
Production of bichromate of		Phosphate deposits near Red			
soda	60	Sea	291	FERRICYANIDES, suggestions for pre-	
Quinine supply in India	240	Poland, chemical industry in	62	paration, analysis and separation	
Roumania, delta cellulose in	60	Poland, imports of chemical fer-		of	298
Sandalwood and orris root in		tilisers	62	Fertiliser and Chemical Trade of	
America	123	Potash, caustic, in France	214	Italy	338
Silk, artificial	61	Rape seed oil, production near		Fertiliser industry, U.S. Government	
Silk Dyers Association	156	Shanghai	94	inquiry into	29
Soap makers in Russia	29	Resin, cactus plant as source of	61	Fertiliser trade in Canary Islands	186
Soaps from Infusorial Earth	337	Salt tax yield, Chinese	214	Fertilisers from brown Tennessee	
Sponges, artificial	184	Soya bean oil	315	rock	290
Steel, new method for harden-		Sugar, refined, exports from		Fertilisers in the Netherlands	125
ing	337	Japan	242	Financial notes and items	32, 63, 95,
Sugar, coconut and palm-nut	213	Sulphur dioxide in Austria	314	159, 187, 215, 243, 292	
Sugar, value of	29	Sulphate of Ammonia in Japan	315	Fire extinction in oil tanks	310
Sulphur from coke ovens	241	Superphosphate Production in		Fire extinguisher, a cheap	184
Sulphur production, Sicilian	29	Piedmont	337	Fisher, E. A. ("Manganese as a	
Sulphuric acid in America	213	Swedish inventions	266	Fertiliser")	319
Synthetic camphor	265	Tanning extract for black man-		Flavouring Extract Alcohol Bill	123
Textile materials	242	grove bark	291	Food adulteration in England	7
Turpentine oil	265	Tartaric acid in Argentina	158	Food and Drugs Act, 1913	165
Turpentine industry in India	266	U.S.A., drugs wanted in	61	Foreign items	292, 316
Useful synthetic product	265	Valparaiso	30	Forster, M. O. ("Scientific Socialism	
Volatile oils in Roumania	156	Venezuela, salt concession in	126	—or Syndicalism ?")	103
Wattle bark extract	240	Continental notes, financial items,		French artificial wood	290
Wood alcohol in Germany	29	etc.	127, 243, 268	Fuel briquettes	263
Wood alcohol in U.S.A.	184	Copper industry, Russian	242	Fuels, recent progress in sampling	
Wood products, Finnish	213	Copper production and price in 1913	148	and testing	19
Wood wasted in sulphite pro-		Correspondence:—		Furnace, electric purifying	56
cess	28	Colour of metals and alloys	209		
Yeast, new method of improv-		The Fundamental Weakness of		G.	
ing, etc.	289	the Science College	54		
Concretes, impervious	183	Mechanicalised Analysis	334	GARNET, abrasive, in America	241
Construction of furnaces for manu-		Crucible v. electric furnaces	131	Gas Engineers, Institution of	
facture of chemicals	115	Crystal Structure new X-Ray Spec-		51st Annual Meeting	189
Consular Reports	30, 61, 94, 125, 157,	trum Analysis of	35	Gas illuminating, ammonia contents	
186, 214, 242, 266, 291, 314,	337	Curacao phosphate mining	126	of	213
Acetic acid, etc., in Uruguay	242	Current legal topics. See Legal		Gelatin, examination of	185
Acetone oil, inquiry for	30	Topics.			
Argentina, borax and salt in	94	Cyanide in U.S.A.	290		
Artificial manure at Reval	30	Cyanides, the simple iron	164		

INDEX.

341

	PAGE
Gelatin shortage in England. . . .	314
General management	119
German coal tar colours	157
German East Africa, technical department for	93
German Potash Producers, Association of	93
German sulphate of ammonia industry	92
Germany, dairy institute in	93
Gimingham, C. T. ("Some Organic Constituents of Oils").	222
Glass, manufacture of, in Hungary .	265
Glucose molecule in fermentation, fate of	39
Glycerine factory in Mexico	215
Graphite as a lubricant	290
Greaves, J. E. ("Occurrence of Arsenic in Soils").	85
Guano discovery in Mexico	265
Gum collecting in New Zealand . .	267

H.

HALE, A. J. ("The Rise and Progress of Electro-Chemistry") . . .	323
Hatschek, E. ("Colloidal Chemistry in 1913") . . .	71
Hatschek, E. ("Surface Tension and Surface Energy and their Influence on Chemical Phenomena") . . .	112, 144, 175, 204, 233, 257, 280, 305, 330
Hawker, A. G. ("Briquetted or Patent Fuels") . . .	307
Hexite-Pentite Theory and its Bearing on the Constitution of Kaolin . . .	192
Hinchley, J. W. ("Notes on Chemical Engineering") . . .	22, 52, 84
Historical chemistry . . .	119
Hodgson, H. H. ("Notes on Recent Theory and Practice") . . .	53, 77, 139, 202, 245, 302
Hong Kong opium traffic . . .	61
Humus in heavy clay soils . . .	209
Hydrogen under high pressure . . .	265

I.

INDIARUBBER factory, poisoning in . . .	185
Industrial chemists, education of . . .	191
Institute of Chemical Research at Washington	123
Institute of Chemistry, 36th Annual General Meeting	111
Institute of Chemistry, pass list . . .	154, 237
Iodine in Holland	313
Iodine, Japanese	93
Iodine in Siberia	123
Iodine number of linseed and petro- leum oils	265
Iron and Steel Institute, Meeting of . .	161
Isomerism, a new form of	250
Italy, chemicals in	94

J.

JAGO, W. (" Current Legal Topics ")	79,
	142, 226, 278
Japan, fertilisers in	186
Java, quinine factory in	60
Jobling, E. (" Catalysis and its In-	
dustrial Applications ") . . .	17, 47, 81,
	108, 147, 171, 199, 230, 255, 283, 326
Johnson, W. S. (" Utilisation of	
Heat from Slags ")	207

K.

KAISER-WILHELM Institute for Chemistry 169

	PAGE
Klein, C. A. (" The Toxicity of Oil Paint Vapours ")	252
Klein, C. A. (" Volatile Paint Thin- ners ")	5
Kershaw, J. B. C. (" Copper Produc- tion and Price in 1913 ")	148
Kershaw, J. B. C. (" Recent Progress in Sampling and Testing Fuels ")	19
Kershaw, J. B. C. (" The Chemist in his relation to Manufacturing Industry ")	74

L.

LEADING ARTICLES :—

Alkali trade, the	245
American methods	129
Chemical products and the war	269
Chemistry and medicine	34
Chemistry on Republican lines	129
College appointments	218
College training and the works	33
English results	130
Hormones or hops	65
Metallurgy and research	189
Motor fuel	65
New lamps for old	293
Nomenclature	130
Position of the chemist	217
Public analyst, the	1
School v. Factory	66
State-aided Industry	317
Technical appointments	97
Universities and their influence	294
Value received	161

Leeds University, chemical department of	13
Legal topics	79, 142, 226, 278
Leipzig, chemical trade of	291
Lignite as fuel	186
Liquid air	241
Liquid air, applications of	153
Liquid in vacuo, large volumes of, Simple laboratory method for continuous evaporation of	230
Lomonosov, M. V.—An early Russian chemist	219
Locomotive, an ingenious	118
Louis, D. A. (" Meeting of Iron and Steel Institute ")	161

M.

MADAGASCAR, monkey-bread tree oil from	61
Magnesite Mining, Panama Canal and	336
Manganese as a Fertiliser	319
Marine propulsion	8
Market reports . . . 31, 62, 94, 126, 158, 186, 215, 242, 267, 291, 315, 338	
Martin, G. ("The Salt Industry")	135
Matches, Japanese, in India	94
Maude, A. H. ("Some Interesting Publications of the U.S.A. Government")	178, 270, 318
Metal markets . . . 63, 95, 127, 159, 187, 215, 243, 268, 292, 316, 338	
Metal sprayer, molten	241
Metals and alloys, method of obtaining a measure of the colour of	132
Mexican graphite deposits	45
Mica and its uses	266
Milk from Soya beans	93
Mineral deposits in Trebizond	242
Mineral deposits, stratification of	177
Morgan, G. T. ("Some Stereo-Chemical Aspects of Residual Affinity")	99
Morrell, G. F. ("Valency and Chemical Affinity")	273

N.	PAGE
NESBITT, C. T. ("Crucible <i>v.</i> Electric furnaces")	131
Nesbitt, C. T. ("Notes on Rapid Methods in Steel Works Laboratories")	295
New companies	64, 96, 128, 160, 188, 215, 244, 268, 316
New Zealand, new industry in	185
Nitrate industry, Chilean.	146, 185, 266
Nitrate of soda, production of	94
Norway, seaweed burning in	158
Norway, new cellulose and paper mill in	315
Notes on Chemical Engineering	22, 52, 84
Notes on Recent Theory and Practice	52, 77, 139, 202, 245, 302
Notes of Meetings. See Societies, Institutions, etc.	

Q.

OCCURRENCE, an unusual	205
Oil, resinous, in mineral oils, de- tection of	336
Oils, Fats and Milk Products.	43, 107, 197
Oil-hardening plant in Norway	92
Oils, new, search for	93
Olive oil, new process of refining	267
Optical properties, the significance of	3
Orange Oil, West Indian	336
Organic compounds in metallurgical practice, use of	9
Oxygen absorption of drying oils, method for determining the	300
Oxygen works in France	123
Oxylene fire-proofing process, the	236

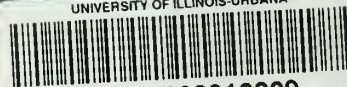
P.

PAINTS for structural steel	310
Paint vapours, oil, toxicity of	252
Paints, permeability tests for	203
Palm saps, process of clarifying	240
Panama Exhibition	124, 184
Patchin, G. (" Use of Organic Com- pounds in Metallurgical Prac- tice ")	9
Patent medicine regulations in Cuba	29
Patent record	25, 59, 88, 121, 154, 182, 212, 230, 263, 288, 312, 333
Patents, compulsory working of	101
Peat, Facterial Treatment of	322
Perkin, W. H. (" Chemical Depart- ment, University of Leeds ")	13
Personal and other notes	16, 51, 88, 114, 179, 207, 226, 235, 261, 285, 304, 329
Petrol substitute, another	118
Phosphate deposits near Red Sea	291
Piecework	287
Poland, chemical industry in	62
Poland, chemical fertilisers in	62
Polarimetry, growth in application of	289
Potash, caustic, in France	214
Potash deposits in Spain	150
Potash industry, Germany	213
Potash salts in Germany	123
Potash in America	314
Potassium Salts, a new source of	335
Pottery glazing without heat	184
Preservatives in lime juice cordial	60
Producer gas, mechanical scrubbing for	87
Production of bichromate of soda	60

Q.

QUININE supply in India. 240

UNIVERSITY OF ILLINOIS-URBANA



3 0112 063910209